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THE JOURNAL OF ENGINEERING EDUCATION

Published by the Society for the Promotion of Engineering Education

Published under the Supervision of the Publication Committee.
H. S. Evans, H. S. Boardman, F. L. Bishop, Editor, University of Pittsburgh.
Published at Prince and Lemon Sts., Lancaster, Pa.

Entered as second-class matter at the Post Office at Lancaster, Pa., under the Act of March 3, 1870.

New Series
Vol. XXII, No. 8. APRIL, 1932 Subscription Price, $3.00 per year. Single Copies, 50 cents.

TABLE OF CONTENTS

Corvallis, 1932. H. S. Evans, President 637
The School of Engineering and Mechanic Arts at Oregon State College. L. F. Wooster 639
Progress in Recent Years in Teaching the Management of Men. O. W. Eshbach 647
The Business Side of Engineering. Eugene L. Grant 655
Coördination Between College Work and Industry. Karl L. Wildes 660
Report of Committee on Method and Procedures of Placing Graduates. Wm. L. Magruder, Chairman 668
Coöperative Employment as a Company Asset. Max B. Robinson 675
Coöperative Training in the Wire Industry. E. W. Kempton 688
The History of Chemical Engineering. Walter L. Badger 691
Discussion: Teaching the Calculus.
Louis O'Shaughnessy 708
William J. Berry 709
New Members 711
Books and Authors 711
Members in Engineering Schools and Colleges 712
T-Square Page. F. G. Higbee, Editor 715
College Notes 716
Sections and Branches 717

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CORVALLIS—1932

H. S. EVANS, President

The Council in session at Purdue University last June decided to accept the invitation of Oregon State College to hold the 1932 annual convention in Corvallis. This decision was reached after a careful review of all the factors involved. Quite naturally some of the members feel that we should always locate the convention as near the center of our member population as possible in order to insure a large attendance and in that manner benefit the greatest number. This argument is sound, as far as it goes, but it seems equally true that we must build up our Society in all parts of the country if it is to perform the mission for which it is organized. If we need supporting evidence of the importance of such a principle we may consider the methods which have been adopted by many of our largest engineering societies. These organizations have been striving in every way to consolidate the interests of their entire membership. Some of the methods used to promote a better understanding of their common problems are: sections, student branches, a division of the whole country into districts each represented by a national vice-president and a local organization, special district conventions sponsored and supported by the national society, and more than one general convention each year held in different parts of the country.

Our Society has made an excellent start in organizing sections and branches and these activities should be encouraged and expanded as rapidly as possible. It does not seem probable, however, that we shall be able for some time at least, to extend our program as some of the larger national societies have done on account of our financial limitations. In fact such an elaborate program would probably not be desirable in the case of the Society for the Promotion of Engineering Education because most of our members are also affiliated with their own professional organization in some branch of engineering or science and duplication of these activities would involve too great a burden in time and expense on the individual who might wish to take an active part in more than one society. It would seem therefore to be the part of wisdom to spread our annual convention meeting places rather widely over the country and thus stimulate a more general interest and attendance.

The arrangement for this year is somewhat similar to that in

which we found ourselves some years ago when the Council voted to hold the 1924 convention with the University of Colorado. At that time we were all more or less doubtful of the wisdom of such a decision, fearing a small attendance and therefore a meeting which would be lacking in enthusiasm and inspiration. The successful outcome of that convention was due to the hearty support of such a large number of the older and most active members of the Society. The success of the meeting at Corvallis as a national convention will likewise depend very largely on the attendance of a large number of representative members from the east and middle west. The extra time and money involved in such a trip will be a sacrifice to some, but there are real compensations to be gained in a better understanding of our national problems in engineering education.

The details for each session are rapidly rounding into shape and Dr. Bishop, who is best able to pass judgment, is confident of an excellent program. Plans are under way for the organization of parties to leave Chicago on special cars at different dates, which should add greatly to the value and comfort of the trip.

A combination of business and pleasure could find no happier setting than the Pacific Northwest and it is to be hoped that an unusually large number of our members will be able to take advantage of this opportunity.

THE SCHOOL OF ENGINEERING AND MECHANIC ARTS AT OREGON STATE COLLEGE

By PROFESSOR L. F. WOOSTER

Professor of Applied Electricity

A previous article in the JOURNAL has given a short description of Oregon State College, its history and aims, and something of its organization. The present article will be devoted to the Engineering School. Something of its organization, its facilities, and the methods used in training embryo engineers for their life work will be told.

The School of Engineering at Oregon State College includes in its organization four degree granting departments, civil, electrical, and mechanical engineering, and industrial arts. Mining engineering is presented in a separate School of Mines; chemical engineering is offered by a separate department; logging engineering is given in the School of Forestry; and agricultural engineering is jointly administered by the Schools of Engineering and Agriculture. A close harmony prevails between these external departments and those of the Engineering School. The faculties coöperate and the rivalries between the student groups are less intense than those in many institutions in which they are grouped in one school organization.

The department of chemical engineering offers two undergraduate curricula leading to the degree of Bachelor of Science, one in chemical engineering, the other in industrial chemistry. The work of the first two years is common to both curricula. Those students majoring in chemical engineering take courses in the mechanical engineering and electrical engineering departments of the Engineering School to supplement their basic and major work. Graduate courses are offered to those who wish to obtain a Master of Science degree with chemical engineering as a major. Suitably equipped laboratories are available for the work in this division.

Mining engineering is organized under the School of Mines. Degrees are granted with majors in mining engineering, geology, metallurgy, or oil production. All students in the School of Mines pursue the same courses for the first two years but differentiate their work in the junior and senior years. These students are also required to take certain courses within the engineering school. Masters Degrees are conferred upon those who complete satisfac-

torily a suitable graduate program. The School of Mines occupies a separate three story brick building.

Logging engineering is administered by the School of Forestry which grants degrees in technical forestry, logging engineering, and lumber manufacture. All students in the School of Forestry pursue a common program for the freshman and sophomore years, the upper division work varying in accordance with the major selected. Graduate work for the master's degree is also offered. In addition to a three-story brick building for classroom and laboratory purposes, the School of Forestry has large areas of timbered and logged-off lands at its disposal for management or experimental work.

The curriculum in agricultural engineering is listed under the School of Agriculture, but is administered jointly under both the Agricultural and Engineering schools. It includes a number of courses within the Engineering School organization. Besides gas engine and other laboratories many implements of the most improved patterns have been loaned by implement dealers for student use.

The curricula in civil engineering, electrical engineering, mechanical engineering, and industrial arts, all lead to Bachelor of Science and Master of Science degrees upon completion of satisfactory work. The courses in mechanics and materials are also listed under this school organization.

All freshmen in civil, electrical, and mechanical engineering pursue the same prescribed work which is classified as General engineering. The freshmen in industrial arts follow a prescribed curriculum which differs materially from that in general engineering. Included in the general engineering curriculum is a two credit course extending throughout the year called Engineering Problems. In this course the students are required to solve problems in mechanics, heat, and electric circuits. They are also instructed in the use of the slide rule, the value of neatness and system in their work, and the necessity for accuracy. They also attend lectures, by different members of the engineering faculty, upon subjects which are intended to illustrate the engineering attitude or to orient the students. This course correlates closely with the work in physics and mathematics and helps to tie it in with typical engineering problems. It has proved itself to be valuable to the students in helping them choose their majors and in their later work.

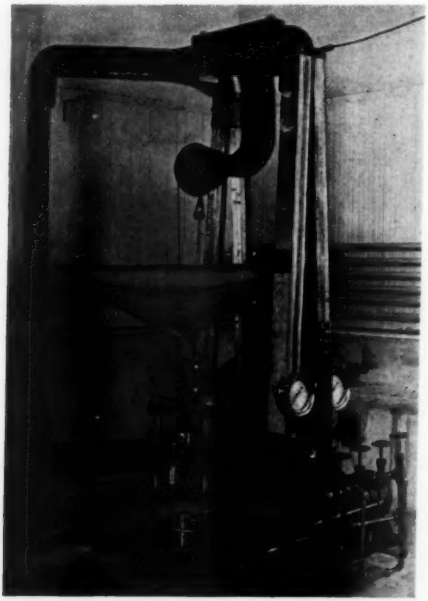
In the sophomore year the curricula in the various departments are broadly differentiated. A three, four, or five credit course is introduced in the field of major choice and some of the service courses differ. The curricula show increasing divergence in the junior and senior years. All of them are planned, however, upon

the same basic pattern and philosophy. Tool subjects and fundamentals are given first; practical work in the laboratories accompanies the theoretical work; application and highly specialized courses are deferred until the senior or graduate years; cultural and humanistic courses are distributed throughout each curriculum;

the work is rigidly prescribed in the freshman and sophomore years but affords increasing latitude for electives in the junior and senior years.

The curriculum in electrical engineering is typical of those in the engineering school. The freshman work in electrical engineering includes courses in mathematics, physics, English, drawing and engineering problems, together with physical education and military science. In the junior year the program is occupied by electrical

engineering (a major course in alternating current circuits and machines, direct currents being treated as a special case), electrical laboratory, statics, dynamics, strength of materials, heat power engineering, hydraulics, national government, principles of accounting, introduction to economics, and three credits per term



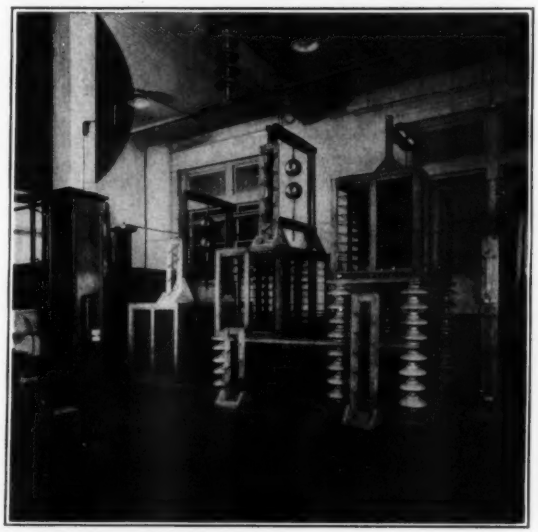
for electives. In the senior year the electrical engineering and electrical design courses are devoted to power plants, transmission lines, and distribution lines with emphasis upon the economic features involved in their design and operation. There are, in addition two terms of power laboratory with an option of communication laboratory for one of them, industrial engineering, hydraulic power plants or heat power engineering, materials of engineering, wood and steel structures. Opportunity is allowed for six credits of technical options and nine credits of more general electives. Numerous courses are available for senior electives and for graduate students in the fields of illumination, transportation, communication, high-voltage engineering, etc.

An advisory system is in use in the Engineering School by

means of which the instructor in charge of the major course in each year's work acts as advisor for all of the students taking that course. A program planning week is scheduled before the end of each term during which the advisor helps those assigned to him to plan their work for the following term or for the year if that seems wise. In this way irregularities are cleared up and special programs planned when they appear desirable.

In the civil engineering department besides the general curriculum there are options in highway engineering and hydraulic and sanitary engineering. In electrical engineering there are no specialized options in the undergraduate work. In the mechanical engineering department there is an option in aeronautical engineering. In industrial arts options are afforded in industrial arts education and industrial shop administration. In conjunction with the School of Commerce, curricula have been planned providing for a major in engineering with a minor in commerce or a major in commerce with a minor in engineering.

Adequate facilities are available for all of the work given. The engineering laboratories are modern and well planned; all of the



equipment can be used with a minimum of wasted effort. In civil engineering, besides the necessary drafting rooms and surveying

instruments, there is a modern hydraulics laboratory including two motor driven 8-inch centrifugal pumps a 35-inch Pelton impulse wheel with oil pressure governor, a 14-inch spiral cased Francis type, and a reaction turbine with Pelton governor.

In electrical engineering, there are available, in addition to the sophomore and general power laboratories, a well equipped standardizing laboratory, an extensive communications laboratory, a storage battery laboratory and a high voltage laboratory. The high tension laboratory contains two 60 cycle transformers, one rated at 100 KVA. at 200,000 volts, the other at 10 KVA. at 100,000 volts; a lightning generator for voltages up to 600,000 with adjustable wave fronts, and the necessary auxiliary equipment. Electromagnetic and cathode-ray oscillographs are included in the equipment of the department, also a small field laboratory and 1,000 meter high tension line.

In mechanical engineering there are three main laboratories for steam, gas, and aeronautical engineering. The steam laboratory is

equipped with turbines and engines so installed that complete tests for economy and efficiency can be made. Boilers are also available

for testing purposes. The gas engine laboratory contains Diesel, semi-Diesel and oil engines in addition to gas engines, also a 100 horse-power Sprague dynamometer. The aeronautical laboratory contains several airplane engines besides wing sections and fuselage.

The mechanics and materials department occupies a large portion of the engineering laboratory with separate divisions for structural materials, cement and concrete, bituminous and non-bituminous highway materials, oils, fuels, and the microscopic examination and heat treatment of metals. The equipment is modern and well arranged. The largest single piece of equipment is the Emery-Southwark 600,000 pound vertical screw testing machine.

The industrial arts department has shops for woodworking, wood finishing, pattern making, foundry, forging and welding, machine work, and sheet metal work.

The executive policies of the Engineering School are formulated with the purpose, as fully as possible, of drawing upon the abilities and resources of every staff member and of developing and promoting the strongest coördination and fullest harmony within the school. A number of standing committees and some special committees have been appointed to study and to follow the development of important phases of the work of the school. It is the duty of these committees to make recommendations to the Engineering school faculty upon purposes, policies, and practices within their respective fields and in some cases to function as operating groups. The executive committee is composed of the heads of the different departments within the school. Its functions are obvious from its name. Other committees of special interest are; that on teaching standards to which is assigned the duty of studying all matters pertaining to classroom instruction and recommending such change as may seem advisable; the committee on freshman instruction which has supervision over the work in general engineering; the personnel committee which deals with all matters of student personnel; and the committee on alumni records and employment, which, in addition to obtaining and keeping records, functions as an employment bureau. The faculty advisors to students function as a committee within the school organization and formulate policies as a group.

In addition to the resident instruction work, the School of Engineering and Mechanic Arts carries on extension work. Numerous classes have been conducted in Portland and short courses in special lines have been held on the campus.

Research is conducted as part of the graduate work in the different engineering departments but since the organization of the Engineering Experiment Station about five years ago, general re-

search has been conducted under its direction. Even in this short time the engineering experiment station has proved its worth to the State and several valuable bulletins have been published. Notable among its projects have been the coöperative projects in concrete mixtures, lightning investigations, elimination of radio interference, and a study of stream pollution.

The members of the Engineering School faculty are looking forward to the Convention with much interest. They anticipate additional inspiration in engineering education and a renewal of friendships with their former teachers in eastern institutions. They hope also that the delegates may take back wth them something of value from their contact with Oregon State College.

PROGRESS IN RECENT YEARS IN TEACHING THE MANAGEMENT OF MEN *

By O. W. ESHBACH

American T. & T. Co., New York City

The extent and diversity in application to industry, of both physical and social sciences, have made the task of the ordinary business executive one of complexity. The analysis of situations, through the isolation of particular factors, becomes increasingly difficult because of the greater number of variables involved. As a result, the requirements for successful management include the necessity for a broader range of information, familiarity with economic trends, and understanding of the human side of the great industrial machine that has been created.

When translated in terms of educational or training requirements, it means that somewhere and somehow potential leaders must be given a broad understanding of factors outside their own fields of concentration and be sensitized to the values in fields adjacent to their own emphatically specialized phase of vocational activity. Whether rightly or wrongly, engineering education has been criticized for failure to meet the challenge of this situation. It would probably be just as fair to ask whether industry has done its full share in the training and stimulation of education among those of potential leadership ability within its own ranks.

Wherever the responsibility lies, the fact remains, that, in the past, those who have gained preferment in business have been those with good native endowments of intelligence. The successful men have been conscious of the need for intellectual growth and have sensitized themselves to values within and without the business which lead to the development of their own personalities. They have been resourceful in integrating their experiences into their own lives.

In the early years of a man's industrial career his chances of gaining recognition and of obtaining preferment depend on his ability to surround technical details of a highly particularized job. In the intensity of his concentration and in the effort to obtain a proficiency in his immediate work, he may not gain insight into the full intellectual and social bearings of his vocation. He may fail to develop interests in fields outside his immediate work. He may

* Presented at the 39th annual meeting, S. P. E. E., June 17–19, 1931.

fail to develop an awareness of the evolving situation about him and may not sense the broad economic and social tendencies in his community or his own industry. He may capitulate to the demands of his immediate work and develop a warped or narrow viewpoint rather than a well-balanced education in book and life and an introduction to the important elements of human experience. When such a man, because of good native ability, is promoted to an executive position which requires the ability of the coordinator, he often discovers the need for those cultural and educational values tangential to his environment which he has had to forego in his early career. He finds that he has neglected those broader fields of knowledge which would have opened the way to larger generalizations and which would have provided resources for the imagination. He sometimes finds himself striving in a world in which all sorts of complex economic and business phenomena are present, the causes and consequences of which he distinguishes vaguely or not at all. He lacks ability to absorb the lessons of experience in his environment, because he is not sensitized to the critical appreciation of their values. If he senses his inadequacy and realizes that the evolution of the business world has proceeded faster than his own development, he will seek to equip himself with the tools and the technique with which to challenge vague impressions, gossip, and tradition, and reach sounder, more broadly considered conclusions on the business problems he faces. If he does not realize his own lack of preparedness, or if he lacks the desideratum of intellectual curiosity to bring himself up to date, may be listed by his bosses as human material which is obsolete, depreciated and inadequate.

In every grade of an organization there are too frequently those who have become self-satisfied because of a conviction of having attained expertness. For these men, progress usually stops; their mental growth ceases; new ideas fail to take root. In many cases, their minds become inactive in their prime because they lack the expectation of further change of outlook. It would seem possible to jolt some from their lethargy in college, by giving them an active conviction that education and mental growth are a life-long process. Certainly it is reasonable to assume that a college atmosphere should be influential in promoting the temper of life which makes growth and change of ideas a natural expectation.

It should be recognized, however, that knowledge of tools with which managers must work, or the things which they have to do, or the philosophy of management, do not constitute management ability, although they are very useful and to a considerable degree must be possessed by those in executive positions. The question is not one of instruction in technique. Neither should the inquiry as

to how management ability may be developed in colleges and schools be misconstrued, for it is more a question of what type of training or courses are best adapted to the development of men having latent managerial ability. Certainly systematic educational work contributes to the development of men possessing the faculties of management, but it does so primarily by developing the intellectual powers of those being trained. We would all doubt the wisdom of curricula designed particularly for men desiring to enter, or believing themselves potentially capable of entering executive positions. Successful executives are men of varied educational antecedents and by the time most of them become recognized as competent leaders their formal education is so sufficiently remote that they have great difficulty in stating any particular courses which have especially contributed to their ability as managers. Undoubtedly it would be of advantage for those entering technical industries to have had a fundamentally sound engineering training, but in most cases it is probable that the value of this particular type of training would be greatest because of its usefulness in enabling the man to function during the intermediate period before he has advanced to an important management position.

We are realizing more and more that the essence of engineering is the management function and that basic engineering training is valuable because it calls at an early stage for precision in mental processes and involves quantitative measurement and statistical methods, both of which are becoming an increasing part of the machinery of management. Economics and sociological studies tend to furnish the student with a background of general business and the essential business problems, to a greater degree than do engineering studies. For this reason such studies furnish preliminary training adapted to certain types of work in the commercial world. They do not necessarily furnish a better training for men who are likely to become managers. This fact, has, however, led to an attempt to introduce more economics in the engineering schools. In recognizing vital training to be that which will develop the ability for thorough study and for the mastery of the particular thing at hand, our training in engineering technique has been widespread and good, but there is an unscratched field in training in human relationships, that lies immediately ahead of us. Of course some individuals get satisfaction in human relationships while others do not. These two types of individuals should be so assigned that each may function in his own field, to the end that organizations contain the minimum of weak spots.

Training in industry for leadership responsibilty should embrace instruction in the following essentials:

1. Responsibilities of the position.

2. Human relations with subordinates.
3. Important elements of other work relating to the new position.
4. Development of the leader's personality.

While training men in skill, the foundations of loyalty may be developed; in learning how to get results, men are taught to be kindly, and in thinking through perplexing situations they learn to take counsel. But how much greater progress they would make if a start in this direction were made at an early and formative stage of their lives. Rather than be blind to human factors in industry, can students not become sensitive and speculative to human experience?

What all need to learn and to impart to students and associates is more about the underlying motives that govern human behavior. Can the principles that govern human relationships be learned? Can they be imparted? Certainly the appreciation of them is essential to adequate development for leadership responsibilities. To be a leader and get results is fine but to do so with the undivided loyalty of the whole crowd is nothing short of glorious.

In the Fall of 1928, the President of our Society, Dean D. S. Kimball, realizing the increasing responsibilities of management placed upon engineers in industry, called a conference of Deans of Engineering and a few industrial representatives to discuss the nature of the problem, what was now being done about it, and also what was probably desirable in the way of helpfulness. Through the courtesy of Mr. Sam A. Lewisohn, the meeting was held at his home November 2, 1928, and was attended by 31 representatives, mostly Deans or Administrative Officers in education.

The full report of this meeting, which consisted of informal discussions of the many phases of the problem, was widely distributed. The S. P. E. E. felt that some action on their part would be helpful in crystallizing opinion as to the relative importance and possible methods of instruction which might be advisable in teaching subjects such as labor relations, personnel administration, and human relationships in management. A committee on College instruction in Personnel Administration was appointed by the President, which later was increased in membership and became the Committee on Instruction in Industrial Relations, consisting of R. L. Sackett, Chairman; V. W. Hallock, D. S. Kimball, J. W. Roe, Sam A. Lewisohn, J. E. Walters, E. D. Smith and F. W. Willard.

At the annual meeting in 1929 the Committee on College Instruction in Personnel Administration submitted a report. It consisted of recommendations regarding books and magazines on personnel administration, a list of books to be read by all engineering students, the amount and character of personnel instruction de-

sirable for various groups of students, the collection of case material, and possible procedure in personality development.

At the annual meeting in 1930, Professor Elliott Dunlap Smith, at the suggestion of the Committee on Instruction in Industrial Relations, presented a paper on the subject, "Can the Engineering Student be Taught to Manage Men?" While he answered the question in the negative, he did present very valuable suggestions and classroom methods which provoked considerable discussion. It seems to confirm the contention that students could be taught to be curious and speculative about human relations and given a background to analyze objectively their human relation experiences in industrial life. The paper was followed by another conference on March 28, 1931, with Mr. Lewisohn as host. It was intended primarily for teachers grappling with the teaching of this subject in both engineering and business schools. Objectives, subject matter, and methods were the topics considered.

In stating desired objectives, Professor Elliott Dunlap Smith emphasized the fact that it was the purpose of courses in human relations to prepare men to matriculate in the school of experience. These courses should, therefore, aim (1) to give students perspective, (2) to develop the capacity for objective analysis of trying experiences in industry, and (3) to make the students sensitive and speculative about all human problems flowing out of their ex perience in industry.

Dr. J. H. Willits of the Wharton School, University of Pennsylvania, gave as a parallel objective, the development in the student of a sound philosophy of human factors in industrial operation.

Joseph W. Roe, Professor of Industrial Engineering, New York University, and Professor Ordway Tead, School of Business, Columbia University, presented their views on the subject matter in courses on human relations. In general they stressed the need for thorough treatment of the social aspects of the Industrial Revolution, the history of labor organizations, principles of sound organization, employment and personnel practice, reasons for labor turnover, and a good groundwork in the psychology of the individual.

The relative importance of lectures, discussions, and case problems as methods of instruction, was presented by Professor H. S. Feldman, Tuck School, Dartmouth College; John R. Bangs, Assistant Professor of Industrial Engineering, Cornell University; John Younger, Professor of Industrial Engineering, Ohio State University, and Professor E. H. Schell, Department of Business and Engineering Administration, Massachusetts Institute of Technology.

The conference was attended by thirty teachers and a few

industrial representatives; C. E. Davies, Assistant Secretary of the American Society of Mechanical Engineers, presided. It was followed by a dinner at which Mr. Lewisohn presided. Gano Dunn, President, J. G. White Engineering Corp., and F. W. Willard, Assistant Works Manager, Western Electric Company, were the speakers at the dinner and stressed the importance of right social thinking on the part of graduates of engineering and business schools who enter industry.

In addition to these group discussions, the subject had received attention at the S. P. E. E. Summer School for Mechanical Engineering Teachers, at Purdue, June 27–July 18, 1929, and a number of interesting lectures were presented on Industrial Organization, Personnel Administration and the History of the Industrial Revolution.

Another meeting is being planned for the near future and it is hoped that out of these discussions will evolve an answer to the "what and how" of instruction which will help men to measure up to their highest possibilities; to do so will be to realize the best that leadership in education is capable of achieving.

Discussion

C. E. Davies, Assistant Secretary, A. S. M. E.

Engineers have long known their need for proper appreciation of the fundamentals of good human relations in industry. Public utterances of engineering leaders for at least two decades have stressed its importance. In the words of William L. Abbott, in his Presidential Address before The American Society of Mechanical Engineers in 1926: "You have long and carefully studied the characteristics of the materials you employ, that your treatment of those materials may best adapt them to the service of mankind. Have you been as considerate of the characteristics of the human bodies and human souls that enter so largely and vitally into your products? Herein lies the hope not only of employer and employee, but of society itself."

General statements of this nature have prepared the way for the series of conferences under the sponsorship of the S. P. E. E. and the leadership of Mr. Lewisohn, Dean Kimball, Dean Sackett, and Professor Smith to formulate thinking in a concrete and definite way. The historic Montreal report of Dean Sackett's Committee mentioned by Mr. Eschbach marks the organized start by engineering educators in arousing among engineering students curiosity and speculation concerning human-relations experiences.

This program is constructive and seems practical. The entire agreement with the stated objectives by those attending the con-

ference at Mr. Lewisohn's home this spring gives evidence that they will form the platform on which expansion of educational activities in this field may proceed. Extension into all engineering educational institutions with the consequent resultant emergence into industry of engineering graduates qualified to deal helpfully with their superiors, their co-workers, and their subordinates is a consummation devoutly desired by the engineering profession.

One point that seems worthy of special emphasis is the fact that every class is a demonstration in good human relationships. Every teacher, regardless of the nature of the subject, whether it be highly technical or not, is in close relationship with his students, and his attitude and his treatment of his subject-matter have an undeniable effect on the minds of the students, on the human-relations experience they accumulate in the classroom. An appreciation of this by teachers will do much to offset the idea that technical training blinds the student to a perception of human-relations problems.

It seems also wise that the engineering profession as a whole should be brought closely in touch with the program that is being carried on, as its influence and aid will be of great help. In developing courses along this line, engineering faculties must have recourse to actual experience in industry, and engineering graduates who are undergoing these experiences seem to provide the best means of bringing them directly into the classroom. Steps for securing this coöperation seem obvious and need not be described in detail here.

The engineering profession is in a receptive mood—not only the rank and file, but especially the younger men who have been thrown into the maelstrom of industry without quite understanding that they must contribute not only to the technical work of the organizations but must have the coöperative spirit.

The American Society of Mechanical Engineers has recently issued a questionnaire to its members to determine facts about the earnings of engineers. In this, some questions were inserted which gave the recipients an opportunity to register their opinions as to

1. Qualities essential for success;
2. What success can do to develop these qualities;
3. What the engineer can do to develop them; and
4. What the Society can do to help the engineer progress in his profession.

Results of the questionnaire have as yet only been partially analyzed, but a preliminary report will be published in September. However, a brief survey of some of the replies to these questions, especially those made by the younger men, indicate that a very

large percentage of them have a real appreciation of the need for arousing their sympathetic interest in human relations while they are still in the engineering school. Looking over the replies to the questionnaire we find that among the qualifications deemed essential for success are the ability to make oneself liked, ability to coöperate with workers, ability to hold school training in check, ability to explain technical work intelligently, understanding of human nature, ability to meet people, ability to work in harmony in human element, etc. Among the suggestions for contributions that engineering schools can make, we find the same ideas expressed in many different ways. Schools are encouraged to include human-nature study, psychological studies, inclusion of courses on dealing with human beings, courses in public speaking, organization of student activities to develop human contacts, guiding personality development, etc. These ideas were evident also in answers to other questions and expressed in much the same wording, and the forceful impression is received that in the engineering profession there is a large body of opinion which will support the work of the schools in following through an aggressive program such as has been outlined by your Committee on Instruction in Industrial Relations. One answer to the questionnaire stands out as summing up the whole matter and I quote it in full: "Technical soundness is of course important; human contacts and understanding are of prime importance; you cannot do real things unless you understand men."

THE BUSINESS SIDE OF ENGINEERING *

By EUGENE L. GRANT

Stanford University

I shall start in by defining the business side of engineering. In doing so, I shall borrow an idea from a professor of philosophy whose course in the History of Philosophy I once attended. He started out his course by asking his students to bring in all the different definitions that they could find, and when he had accumulated all of them and discussed them with his class, he then said: "Probably the best definition of philosophy is to say that anything that has ever been called philosophy is philosophy." I shall go one step further in adapting his definition and say that, for my purpose this morning, anything that has ever been called the business side of engineering, or might possibly by any stretch of the imagination be so called, is the business side of engineering.

If one accepts this liberal definition, it is safe to say that the business side of engineering is now recognized by nearly all administrators of engineering colleges as an important field of engineering instruction. I think that is an accurate statement and a significant one, particularly so as it represents quite a definite change in viewpoint within the past ten years. Even as recently as ten years ago, attempts to introduce courses of this character were likely to be looked on with anything from mild disapproval to active opposition. Many engineering teachers and administrators of engineering colleges felt that to include instruction in the business side of engineering was certain to weaken the rigor of engineering training.

This attitude on the part of administrative circles was vividly impressed upon me in my own personal experience when asking for advice with regard to this field. During the summer, just ten years ago, I came east from Montana, where I had been teaching an engineering economics course that I had inherited from my predecessor, and I made it a point to talk with a number of men who, I thought, ought to be in a position to predict what was going to happen in engineering education. I was enthusiastic about the border-line field of economics and engineering, and I felt that it was important that instruction in this field be developed, but I

* Presented at the 39th annual meeting, S. P. E. E., Purdue University, June 17–19, 1931.

was uniformly discouraged by those with whom I talked. One engineering dean said to me, "I am absolutely opposed to putting such courses as engineering economics into the curriculum." I was advised by one man of wide experience in education that if I attempted to cultivate the border-line field of engineering and economics, I might be like the bat, who was acknowledged by neither the birds nor the beasts.

That attitude has all changed, I think. Anyone who talks now with deans of engineering colleges and department heads gets the feeling that they recognize quite clearly the importance of this field, though many of them feel that they are to some extent groping in the dark as to just what ought to be taught and how.

Although there was not general recognition of the importance of presenting the business side of engineering in engineering instruction until recently, many individuals have realized for a long time the desirability of doing this. Many of the general courses that have been taught in this field date back to the period when the instructor developed his course in the face of the indifference or even the opposition of his colleagues. For this reason courses in this field have been developed from a wide variety of viewpoints; it is not too much to say that each course has reflected to a considerable extent the personal experience of the man teaching it.

It seems to me, however, that most of the developments of general courses in this field come under four major classifications:

1. Courses in economics for engineers.
2. Courses in business administration for engineers.
3. Courses in factory management, and
4. Courses in what has usually been called engineering economics.

In many cases, the engineering faculty has gone to the economics department of its institution and asked that department to give the engineers the standard course in general economics, or perhaps a particular course in economics for engineers. A second type of introductory course in this field has been the course in business administration, which attempts to survey the entire field of business activity. In some cases, such a course has been taught in the college of commerce or business administration. In many other cases, however, such courses have been taught by members of the engineering faculty who have developed them particularly to meet the needs of their own students. These first two types of introductory courses do not have engineering origins.

However, there are two other distinctive developments that have grown up within the engineering schools; one, the course in

factory management or industrial management or industrial organization; the other, the course in engineering economics, which has emphasized the long-run cost comparisons necessary in engineering and the financial and other calculations incident to answering the ever-present question: "Will it pay?" As I said, these are distinctively engineering developments. If you go back to the origins of these two fields, the prophet of the factory management group was Frederick W. Taylor; the prophet of the engineering economics group was Arthur M. Wellington.

While these four developments have not been mutually exclusive—for in many cases all of them have occurred in the same institution—there has been much privately-expressed skepticism between the advocates of each of these types of course with respect to the merits of the other types. Many economics professors have been decidedly skeptical of the merit of any attempt on the part of the engineers to develop courses in economics and business. On the other hand, one frequently hears the expression from members of engineering faculties that "We cannot get what we want from the economics department." I have even observed brickbats being thrown in private at all of the other three types of courses, and such brickbat throwing was not done by men who were skeptical of the desirability of instruction in the business side of engineering but rather by men who were thoroughly convinced of the great importance of this field. The business administration course was criticized as trying to cover too much ground, as being spread out too thin to be of any value. The management type of course was criticized as mere talk. With respect to the engineering economics type of course, I was told by one man, "I can't see why a course needs to be given in such elementary stuff. What is needed is rather a good course in cost accounting."

Despite these mutual differences of opinion, there is a growing tendency among the advocates of these different types of courses to borrow from the other fellow. I suppose many of us that are here this morning have taught several of these different elementary courses. As Professor Ennis has pointed out in a paper presented to this Society, this diversity of approach to the business side of engineering is really representative of a healthy condition in the development of a new field. A too-early standardization of the subject matter would have been unfortunate. What each man has taught has been colored to a considerable extent by his own experience and his teaching has gained rather than suffered thereby. However, I think we have now reached the point where those of us who represent different points of view can get together to advantage. Of course, this getting together has gone on to some extent for the past six years or more. The Clearing House of

Engineering Economics, under the sponsorship of Professor Fish at Stanford, has had members representing all of these four points of view that I have mentioned. Problems and other material have been exchanged with much advantage. This is a good thing and should continue. However, we need to get together in a situation where we can both exchange experiences and argue about our differences of opinion. Such an opportunity for discussion is afforded by such meetings as this one and would be afforded to even a greater extent by a summer session for teachers in this field.

Of the many unsettled points in this field, I should like to raise five which, it seems to me, may profitably be discussed immediately. They are as follows:

1. What shall be the content of the introductory course or courses in the business side of engineering?

2. Of the many supplementary subjects available for detailed study within this field, most of which are taught by non-engineering instructors, which can most profitably be developed by engineers to present a distinctively engineering viewpoint? I refer to such subjects as Accounting and Cost Accounting, Industrial Relations, Business Law, Corporation Finance, Public Finance, Public Utility Regulation, Marketing, Patents, Valuation, and Statistics. Another subject, Contracts and Specifications, has been distinctively an engineering development and does not raise this particular question.

3. By whom and under what plan of organization shall this instruction in the business side of engineering be given? Shall it be by the Economics Department or the School of Business; or by a separate department set up within the College of Engineering, which may be called by such a name as Department of Economics of Engineering or Department of Engineering Administration or Department of Industrial Engineering; or shall the instruction in this field be given by the individual Departments of Civil, Electrical, and Mechanical Engineering, etc.; or shall it be done by a combination from all of these possibilities?

4. How shall engineering curricula be organized to allow the interested students to have more than one or two introductory courses in the business side of engineering? Shall this be done by providing an increased number of elective units in the junior and senior years of the course; or shall it be done by setting up definite alternatives of technical and administrative options within the older degree courses of civil, chemical, electrical, mechanical, and mining engineering; or shall a separate degree course in Industrial Engineering or Administrative Engineering be given?

5. Can we standardize on a name for this general field, or at least standardize the meanings of the names that are at present

used for its subdivisions? This problem of a name for the field is an interesting subject, which has had recent discussion among the members of the Clearing House of Engineering Economics. In this discussion pertinent objections have been raised by one member or another to almost all of the names that have been proposed for this field.

I offer you these questions for discussion this morning at this meeting and for informal discussion in our spare moments during the next three days.

COÖRDINATION BETWEEN COLLEGE WORK AND INDUSTRY *

By KARL L. WILDES

Assistant Professor of Electrical Engineering, Mass. Inst. of Technology

The hand-in-hand progress of classroom instruction and its practical application in an industrial setting is undoubtedly one of the greatest contributions of the coöperative method of engineering education. It is therefore presumably an ideal of every coöperative course so to arrange the periods of study and practice that the greatest stimulus of the one on the other may accrue to the student. The opinions of some prominent men in industrial as well as in educational circles that coördination, although theoretically desirable and practicable, is in fact not being accomplished and is next to impossible, evidence how far short of the ideal some cooperative courses are falling.

Much has been said and written about the benefits that could come from the correlation of the theoretical and the practical aspects of engineering education under the coöperative plan, and properly so in the years when this plan was only a dream. But cooperative education has been designed, manufactured and given the factory test. It has been pretty well sold and is now in the utility stage of its existence and from this position it can answer from experience the question "Is coördination a reality?". Of course the answer is "Yes and no" and, since only the "Yes" part of this answer is constructive, this discussion will point out and illustrate two methods of coördination that are actually working in the engineering colleges and industries of this country.

Just for the sake of naming these two methods, one will be called the "synthetic" method and the other the "analytic" method of coördination. The synthetic builds up out of many jobs in perhaps many manufactories and public utilities an industrial training program while the analytic analyzes a single comprehensive organization to find within that organization an effective course of practical experience.

In either case the curriculum of scientific and liberal subjects is laid out in the manner found to be educationally the most ef-

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ficient for a given institution and for the coöperative situation at hand.

In the synthetic method, the sequence of jobs and their relation to the college curriculum are largely dependent upon a member of the college faculty called the "coördinator." His function is to canvass the local industries (sometimes 75 or more concerns) and to find where in these industries, coöperative students can be placed. In the early days he had to sell the idea to the foremen and superintendents in the shops and obtain their consent to place one or two men on various jobs for trial, but now in cities where this system is well executed and has gained popularity, the coordinators very often have requests from the industries for students to fill continuously some particular jobs. In this way the coordinator maintains in times of normal business an adequate list of all kinds of jobs from which he selects and builds a course in industrial practice. The more menial and less specialized jobs he places among the early assignments and those jobs approaching the professional aspects of engineering he places late in the course when the student has mastered some of the scientific principles and has developed maturity and judgment enough to do this more exacting work creditably. Moreover, in many cases the jobs are coordinated with the scientific studies in the college, especially in the later years. A quarter of a century of experience has developed a few coördinators who have a personal and office technique in this system which has become an art, and such men have been responsible for the successful development and maintenance of this method of coördination.

Coördination by the analytic method as practised at present is not centered in a coördinating officer. A committee representing the educational institution and the particular comprehensive industry concerned studies the possibilities for training within the industrial concern and finally lays out a *course of practice* the elements of which are graded and coördinated with the program of scientific study. If, for example, the concern under consideration is a large urban electric transportation company, a practical course in electric transportation is laid out beginning with the checking of troubles at the carbarn and ending in the General Manager's office, all the way along lining up the elements of this practice such as rail welding, electric motor repairing, switch and signal maintenance, etc., in their proper relation to the electrical engineering and other subjects of the study program.

Just as important as the laying out of the coördinated program is its administration. An officer of the company, usually a member of the personnel or educational board, is responsible for carrying

out the assignments as designated by the committee, and to this officer the students, report while in the employ of the company. To these officers the analytic method owes much of its success, for unless the project is carefully supervised within the industry the maximum educational value of the practice is not obtained.

Another important factor contributory to smooth and effective coördination is the presence two evenings a week on the company's premises of members of the faculty of the educational institution for the purpose of academic instruction and correlation. Thus the students are continuously getting both the classroom and the job points of view. Many instances arise in which the reasons for certain practices of the company are brought out by the professor teaching the evening class in answer to questions by the students.

Two examples of the analytic method will be given.

1. *Electrical Manufacturing.*—The Massachusetts Institute of Technology and the General Electric Company coöperate in giving a course of fundamental science and manufacturing practice for students interested in preparing themselves for the technical and executive positions in electrical manufacturing organizations. This course contains all the essentials of the Institute's regular four-year course in electrical engineering plus a complete year of graduate study and research. It also contains a course in manufacturing practice the component parts of which are carefully selected out of the extensive manufacturing enterprises being carried on in the Schenectady, Lynn, Pittsfield and Erie works of the General Electric Company. For the successful completion of this combined course of scientific study and its application the degrees of B.S. and M.S. are awarded.

First of all, two years of basic study in mathematics, physics, chemistry, English and drawing are required as a foundation for the professional studies in electrical engineering and their industrial application. During this time the student proves himself capable of mastering the particular kind of study necessary for engineering and decides where he most desires to apply his engineering abilities. Also, at the end of this period in order further to assure all parties concerned that the individual men are not making a mistake in going into any of these courses of practice, the regular employment personnel group of the company interviews the candidates and selects the men who are believed to show promise for electrical manufacturing. The class thus selected is now divided into two groups which alternate between the Institute and the Works during the remaining three years.

Instead of going through the five year program some students prefer to attend a college of liberal arts for four years covering during this time the subjects required in the first two years of

the engineering course, and some additional subjects. With this foundation it is possible for men of good ability to enter immediately upon the coöperative program and complete the course in three additional years.

In order to show clearly the coördination between the work and the study, we will follow a specific case through these three years. We have selected as an example a man who went to the Lynn Works for the summer following his second year. Here we find one of the finest machine-tool training shops in the country, and in this shop Mr. A, as we may designate him, got his nine-week course in machine-tool processes. He not only learned how to use lathes, shapers, milling machines, etc., but was taken by his instructors through the industrial machine shops of the plant and shown how machine work forms the backbone of electrical manufacturing, and how a designing engineer must be familiar with materials and the ways of manufacturing them into the finished product. Incidentally he noted also the type of men employed to operate these machines and was afforded the opportunity to study some of the problems involved in keeping these machine shops running smoothly. It is a very short sighted student indeed who does not coördinate his elementary principles of mathematics, mechanics and economics with the work of this assignment. Two evenings a week, during the first six weeks of this summer, a member of the M. I. T. staff taught an evening class in business English, followed during the last nine weeks by a course in direct-current machinery. After this latter course had been in progress about three weeks, Mr. A was transferred to the direct-current motor test where both engineering tests and commercial tests are run. In this way he became intimate with saturation curves, heating of field coils, armature windings and bearings, effects of series field turns and weak fields, etc. These experiences gave him incentive to apply himself to the study of the principles upon which these machines operate as the opportunities both in the shop and in the classroom presented themselves.

Mr. A then went back to M. I. T. and took a course in direct current machinery laboratory where he found opportunity further to investigate the behavior of these machines. The other subjects studied during this term were: alternating-current theory, economics, partial differential equations, applied mechanics, and thermodynamics.

Upon his return to the Lynn Works in February Mr. A. studied alternating-current machines in his evening classes while for the first twelve weeks he was assigned to the alternating-current motor test, and the last six weeks to the constant-current transformer test.

Then came the summer term at M. I. T. with alternating-cur-

rent measurements laboratory, class-room study of synchronous converters and induction motors, more applied mechanics and thermodynamics.

After a month of vacation, Mr. A. was found in the Schenectady Works on an assignment in the radio and vacuum tube laboratory where he did a piece of research in the development of a certain type of vacuum tube. His class work during this term was in electric power transmission.

The last undergraduate term was spent at M. I. T. completing electric power transmission, electrical machinery laboratory, electron theory and apparatus and other subjects.

Mr. A. now entered upon a year of graduate study, beginning with an assignment in the rectifier research laboratory of the Lynn Works. Here under the direction of the laboratory staff a piece of industrial research was carried out. These research jobs usually prove so interesting to the student that a thesis grows out of some special phase of such an assignment, this thesis being continued and completed during the final academic year which is all spent at the Institute. Mr. A. elected a program of graduate study and research during this final year and received in June both the degrees of Bachelor of Science and Master of Science.

It is not essential, of course, that an assignment in direct-current machines accompany the classroom study of the subject, but the two should be near enough together at least to allow one to stimulate the other. Not every man follows exactly the same course of practice but in all cases, care is taken that the practice assignment is suited to the individual aptitudes and to the educational background of the student at the time. The case of Mr. A. was selected to show that close coördination is possible and is actually realized.

Some specialization is shown in the industrial practice toward the end of the course in this illustration and it is interesting to note that Mr. A. is now permanently employed in the laboratory in which he held his last practice assignment.

One of the pleasing observations in this course is the harmonious relation between the students and the regular testers. It is not at all uncommon to find a student explaining to the regular tester some of the theoretical aspects of the class work, the theory of armature reaction and the purpose of interpoles, for example. But in return the student holds the tester in high esteem for his skill in manipulation, and is pleased to make progress in dexterity while making connections and in confidence when throwing switches.

2. *Power Generation and Utilization.*—A second example of the analytic method of coördination will be considered in lesser detail since the general plan of basic study and the periods of alterna-

tion are the same as in the first. The Edison Electric Illuminating Company of Boston is a large producer and distributor of electrical energy and administers a well-coördinated course in its field. Let us follow Mr. B. (also an actual and typical case) through his industrial assignments.

In the summer following his second year, Mr. B. was assigned to the maintenance department where he repaired transformers, aided in pole setting, cable-splicing, electrolysis tests, and tests for faults. This work ties in very well with the general basic sciences and principles of electrical engineering studied in the preceding term but not so definitely with the evening class in direct-current machinery given during the summer term.

The next spring term of practice follows the Institute term in which some of the economic principles encountered in public utility management are studied. Here Mr. B. was first assigned to the sales department where he learned to compute and to compare customers' rates and to compute the power needed by a potential customer. Then there was a week in the supply department, then short periods in the meter division and in the incandescent and arc lamp divisions of the installation department, and finally seven weeks in the standardizing and testing laboratory. The evening class-work was on alternating-current machinery.

The third practice term follows the summer term at M. I. T. in which the subjects of thermodynamics and alternating-current machinery are completed. Mr. B. was first assigned to the boiler room of the "L" street station where he aided in repairing and operating the boilers. This was followed by periods in the turbine rooms of both the "L" Street and Edgar stations at the latter of which are three high-pressure turbine generators using steam at 1,200 pounds per square inch. Short periods were spent in alternating-current and direct-current substations and in the battery division and finally seven weeks were spent in the technical division of the generating department where statistical charts and maps of the system were prepared. The subject of evening classroom instruction was electric power transmission.

The graduate practice term was spent in the engineering offices where electrical engineering studies are made on distribution and high tension transmission circuits and on economic and technical aspects of service expansion problems. In this term the correlation is almost always very close since the methods used on short-circuit analyses, load studies, and system tie-in problems are usually being studied in the classroom during the graduate year.

In Mr. B's case, the undergraduate instruction at M. I. T. was precisely the same as in Mr. A's, but the scientific principles were

correlated this time with a different set of applications and therefore found in these applications a different emphasis.

Further examples of this kind of coördination could be given in these fields and our work in the fields of electrical communication and transportation but it may be more interesting to review some of the unsolicited comments of students on the weekly report sheets on this matter of coördination. These are quoted verbatim from the reports of various students.

Manufacturing Option

Direct-current Motor Test

"My work this week has exactly fitted in with the course in P. E. E. which I am taking. I find that the questions arising from practical experience often have answers which lead towards the understanding of parts of our d.-c. textbook which, when studied in class, had no particular significance to me. The practical work and the class work make each other more interesting."

"My work on mill motors is helping a lot in my study of d.-c. machinery."

"My work on d.-c. motors could not have come at a better time. It helped me while we were having our class in principles of d.-c. machinery and I believe the experience I gained is going to help a lot during my laboratory work this Fall."

Alternating-current Motor Test

"This is a dandy assignment. It is extremely interesting and is giving me a better perspective in regard to my study of a.-c. machinery."

"I am seeing the application of my previous studying in the 'Principles of Electrical Engineering.' Both d.-c. and a.-c. machinery combined give a wide application. My having taken the laboratory course in a.-c. machinery last summer has been a real advantage to me in this test."

Miscellaneous

"This week I have been answering letters, answering complaints, issuing manufacturing instructions, and collecting data. The work gives me a chance to practice what theory I learned in G442 (Business English)."

"Adjusting an instrument so that it worked correctly gave me a real understanding of its operating principles."

"I had a chance to see some of my 'Alternating Currents' in practical application and could check some of the theory which we obtained on converters."

"This is a practical application of my 'Technical Electrical Measurements Laboratory' and is a great aid in learning the practical methods of using the instruments we tested in T. E. M."

"I have had an opportunity to learn considerable about the application of perfect gas theory to centrifugal compressors for service with gases other than air as well as with air. There has been a good chance to learn a great deal about the design of steam turbines and some of the special features of the General Electric turbine."

The weekly reports not only point out the successful coöordination but serve as a great aid to the administrators in improving the coördination.

There is the possibility of an extreme coördination in which a student would study a certain subject, as for example shunt motors, and then immediately make the application in the motor test. Such coördination would require an unjustified amount of attention in administration and moreover would not be desirable since it would allow the student almost no opportunity to organize his own processes of application. It appears that the examples cited afford just about the right degree of coördination to be most effective.

REPORT OF COMMITTEE ON METHOD AND PROCEDURES OF PLACING GRADUATES *

The subject of the placement of college graduates is of greater importance than ever before because of the present scarcity of positions, the decreasing demand for graduates, and the increased supply. Many of the larger companies have not as yet found suitable places and work for those students whom they took into their employ a year ago and have not yet let go. They and other companies have decided to take on no one from the class of 1931, and are content to canvass the graduates with the object of calling for them should a demand later arise for their prospective services. Several companies have declined to employ even the "rare man" after they have found him. They are not just particular whom they put on, but will take none. As the students say, the employers are "super-choosey," and rightly so in view of their business conditions. Rather than remain idle on full time or to work only part time, some graduates have secured work more to their liking and with other companies. Doubtless most college professors having to do with the placement of their graduates have made many efforts during this last four months to find the most suitable work for their most promising students, but their influence does not extend to making positions where no such positions are needed and where older and more experienced men have recently been dismissed. Fortunately for us in engineering, the industries are able to absorb most of the graduates into some kind of work and this is more than can be said for the graduates in business, commerce, education, and law, while those in agriculture who came from the farm usually have the farm to which to return.

Certain questions have recently again arisen. Have we been attracting and graduating more students than should rightfully receive an engineering education? Is the quality of the student-output poorer and the numbers greater than heretofore in proportion to the needs of the industries which we serve and develop? Are we doing a poorer job of training these young men than we once did? Should not engineering educators in particular stop, take account of the stock that they are graduating, and think what can be done to improve the product of the colleges even if at the risk of a much greater wastage or transfer of human material?

* Presented at the 39th annual meeting, S. P. E. E., at Purdue University, June 17–19, 1931.

In the last twenty-five or thirty years, personnel systems of various kinds have come into existence in the larger industrial and business organizations of this country, and have caused the formation of corresponding personnel departments in many of the colleges. In many colleges the members of the departmental faculties act as the personnel directors for their respective departments and as the liason officers between the representatives of the industries and the undergraduates, graduates, and alumni of their departments. The whole subject of personnel has outgrown its original program of providing an employment bureau for the students and an intelligence headquarters for the employers. Few professors appreciate the strides which have been made in this enlargement of the duties of the teaching profession, even if limited to engineering graduates. It is a development of industrial psychology as applied to engineering since 1918.

It may interest some to learn that besides the many books on the subject which have been published in the last fifteen years, there is an American College Personnel Association whose eighth annual meeting was held in Detroit last February jointly with the National Vocational Guidance Association, the Personnel Research Federation, and five other kindred associations; that Prof. J. E. Walters, Director of Personnel of Purdue University, is the present president; that the Personnel Research Federation publishes a bimonthly now called "The Personnel Journal" which was once called the "Journal of Personnel Research"; that this Journal is "devoted to industrial psychology, the science of work, the human factor in management, and the satisfactory adjustment of individuals to their occupations"; that the American Management association publishes a quarterly called "Personnel" now in its eighth volume; that a number of companies have put out "Personnel Manuals" or instructions to their recruiting teams and Branch Managers advising them of the kinds of men and the desired attributes which are sought for production, engineering, and sales positions with their company; that a number of engineering colleges have published bulletins on "Vocational Guidance," on "Engineering as a Career," and "Directions for Self-Appraisement for Prospective Engineering Students"; that a Personality Inventory has been prepared by Robert G. Bernreuter and published by the Stanford University Press, and that this test is said to be "Quite reliable and to give high (0.89) coefficients of correlation when compared with other widely used tests in the same area"; that Bulletin Series 26, No. 9, Feb. 1, 1931, of the Carnegie Institute of Technology, gives the record and conclusions of "Twenty-Five Years of Personnel and Placement Work," in the service of

the student and alumni of that institution, and of their employers; that the old "advisory" system of the Arts Colleges has been expanded into committees made up of representatives of the various departments concerned and under the leadership of a Director of Personnel, or Personnel Secretary, or Chairman of the Industrial Coöperation Committee, or the Dean of Men and with the assistance of the Junior Dean of the college. In fact, the subject has become a division in some institutions and one of great importance to students, alumni, and employers.

Several engineering departments and colleges print a booklet giving the pictures and the biographical records of the members of the graduating class, so that employers can more quickly evaluate the previous training and experiences of possible employees and can so spend their time in interviewing only those students whose records of scholarship, college activities, and practical experience in industry, and whose photographs, make an instant appeal. At some colleges, individual photographs are used; at others, a large group photograph is given to each employer. At one institution, it is reported that the man in charge picks out those students whom the employer should interview in order to get the kind and type of man that the personnel director thinks the employer desires, and with the object of conserving the time of the students and employer.

The present accepted practice is for the colleges to approve the time of the visits suggested by representatives of the employers and as may best suit the itineraries of the visitors and without too serious conflicts with other activities, vacations, and the visits of other recruiting teams. Harmony and good-will on both sides have prevailed in these matters. However, visits in February, March, and April from men from two scores of companies not only take some time away from regular class-room and laboratory work, but they tend to disrupt the study on the day's work by the students comparing notes and discussing their impressions and conclusions. But it should be remembered that such conversations have much educational value.

It has been suggested by Professor E. Willis Whited, Director of Coöperative Work at the University of Pittsburgh, that a "committee of this Society arrange the schedules of the various recruiting teams, with the object of compressing the industrial interviewing at any one school into one or two weeks. During this time the faculty would expect to have its classes disturbed considerably. It would benefit the student, because his attention would be diverted from his studies for only a relatively short period during his last year. It would help the employer because he would be able to learn how the students at a given school reacted to his proposals

sooner than he can under the present system. It would aid the faculty because they could arrange the senior courses with the knowledge that they would be interrupted for a short while only." Professor Whited's suggestion is not novel. Its usual form has been that the Personnel Directors be invited to visit a particular college in the week following the final examinations of the first semester, or of the Winter quarter. Students who are interested in getting work with one of the visiting companies could attend, while others who purposed returning to their previous employer, or who had already secured work and did not desire to make new contacts, need not spend any time in interviews, nor in loafing for a week or two in term time while their classmates were trying to secure jobs. Other practical difficulties will doubtless present themselves to your minds.

Even a superficial examination of the so-called "Interview Blanks" as used by employers show that they range from none at all to those of four pages or more in length and that, to answer them completely, requires much time and thought, even assuming that the person answering has the data and the knowledge of what the compiler of the blank meant by such terms as "leadership" and "initiative," and how he distinguishes between them.

The American Council on Education is wrestling with the subject of a "Rating Scale" which can be used and applied alike by all. Much has been written on this subject, and the end is not yet. Possibly this Society should lend its formal assistance to the solution of these two problems of the preparation of a simplified, yet complete, Interview Blank and of a Rating Scale which will be fair to all parties concerned.

Since 1920, the Pennsylvania State College has been holding annual Industrial Conferences each May. Technical Bulletin No. 3 for 1927 states that "the purposes of these conferences have been to obtain a better mutual understanding of the aims of the college, and industrial training for prospective engineers; to discuss methods of training in college and in industry with a view to better understanding and coördination; to consider methods of selection and placement of technical graduates; to combine efforts so far as practicable in an attempt to make the processes of training and placement more effective; and to assist the student in reaching a larger measure of usefulness and happiness."

Purdue University in 1929 held a Conference of College Personnel Officers who discussed for two days "College Personnel Procedures" with an attendance of ninety-nine persons from over fifty different colleges. We note among the titles of the papers presented "Personnel Techniques," "Methods," "Coördination,"

"Development," "Records," "Procedures," "Placement," "Personnel Research," "Vocational Guidance," and "What Industry and Business Expects of College Personnel Work." The 74 pages of Bulletin No. 21 of the Purdue Engineering Extension Department are supplemented by sixteen pages devoted to the "Personnel Service of the Schools of Engineering of Purdue University" by the Director of Personnel, Mr. J. E. Walters. This bulletin makes very suggestive reading.

The industrial conferences held at The Pennsylvania State College have brought together a number of the leaders in the industries of Pennsylvania and nearby states who offer employment to the engineering graduates of that college, and but very few educators from off the campus, whereas at the Purdue Conference of 1929 the reverse was true. Both types of conferences have dealt with the "Whole Man" and the training of his personality, appearance, mode of thought, as well as with his training, rating, placing, and promotion. As Dean Sackett said in his "Foreword" at the Tenth Industrial Conference in May, 1929, "These conferences have given to the industries and to the faculties of the colleges a clearer understanding of the intimate problems concerned with the graduate and his introduction to employment." At that conference, the program was marked by the contributions of the Personnel Research Federation with special emphasis on industrial psychology.

Conferences at which the large majority of the members are either teachers or industrialists are likely to be one-sided in their discussions and biased in their conclusions. Both sides of the picture are needed to make up a well-rounded and balanced whole. For example, the report of the Committee on "The Ethics of Employing Engineering Graduates" was presented, accepted, and adopted as a regular committee report at the Ninth Annual Industrial Conference in 1928 at The Pennsylvania State College and was repeated in 1929 apparently without dissent by the educators present to Item 4, which says that "The Engineering School should not refer employment possibilities to the employed graduate, except upon his application, nor attempt to separate the graduate from his employment without first having taken the matter up with his employer." If such is good ethics, many persons are unethical, and do not hesitate to tell an employe of the possibilities for service and advancement elsewhere without either being asked to do so or first obtaining the permission of the present employer.

Besides the Personnel Research Federation, the American Management Association has been holding "Personnel Administration Conferences" for a number of years. Its Committee on College

Employment of which our Past-President, R. I. Rees, is chairman, "sent out a questionnaire to 1,125 companies who employ college graduates, received some replies from 268 companies, and fairly complete replies from 170 companies. These last have now been tabulated and summarized and the preliminary report of the committee is now available, and has been sent to all those companies which answered its questionnaire." "It is mainly statistical in form, ten pages in length, and does not attempt to interpret the factual information which has been received, or to make any recommendations concerning the best procedure. The committee's final report will be presented at the meeting of the Association's Personnel Section to be held in Pittsburgh during February, 1932."

An increasing number of industrial and business corporations have inaugurated, or are about to start, as soon as business conditions warrant the effort, personnel systems for the selecting, training and absorbing of men of various kinds from the colleges into their organizations with the object of making prospective executives from such carefully selected material. A number of successful executives are desirous of seeing to it that they are succeeded by well-trained and competent men. To this end they have written somewhat on the subject and have told what, in their judgment, makes for success in business and industry.

Trade publications and house organs have contained much readable matter on these subjects in recent years.

Reference to the publications of this Society will show that several papers have been presented on various phases of personnel, vocational guidance, and industrial relations.

The National Engineering societies are giving more and more attention to the problems of personnel, placement, and management, as the leaders feel that it is essential to their success that they should have well-trained and capable assistants and that to become a "captain of Industry" presupposes the employment of capable lieutenants.

This all shows that business executives, as well as engineers and educators, have an interest in the subject of the personnel, placement, and advancement of the college graduate. It is thought that an increasing number of our engineering graduates will find a place for themselves in personnel work in the industries.

The reports of the U. S. Civil Service Commission are seldom considered as entertaining reading, but the one for 1929 contains matter of much interest including that portion of the Report of the Director of Research dealing with the "Greater Utilization of Improvements in Personnel Work."

"On April 27, President Hoover issued an executive order

establishing a Council of Personnel Administration which will endeavor to develop a more effective system of personnel management in the Federal Government.'' The president of the U. S. Civil Service Commission, Mr. Thomas E. Campbell, is to act as Chairman of the Council. Of the thirteen members of the three advisory committees which have so far been appointed, six are members of our Society. (Messrs. W. W. Charters, J. W. Dietz, W. S. Donald, C. R. Dooley, C. R. Mann, and L. W. Wallace.)

In view of the above statements of the facts gathered from observation and recent reading, it must be apparent to all that the duties of an engineering college educator do not stop with the formal instruction in the class room and laboratory, but should include much more in the preparation of the student as to his personality, mode of thought, appearance, and his placement and subsequent advancement in industry.

With this end in view, the chairman of your committee takes the liberty of suggesting and recommending to the Council of the Society that a meeting be held in 1932 either in connection with or just preceding the annual meeting of the Society; that the keynote of the meeting be ''The Personnel and Placement Problems of the Students, the Colleges, and the Engineering Industries''; that a committee of seven men who are specialists in this branch of engineering education and are young and full of enthusiasm be appointed by the President of the Society to arrange for the details of the meeting, provide the program, the subjects of the papers, and the speakers and discussors; that this committee include two or more personnel directors from colleges and also from the industries; that the American College Personnel Association be invited to join us in this meeting; and that special efforts be made to interest personnel managers, directors, and secretaries, employment managers, recruiting teams, and the membership of kindred societies in the meeting and the program, and in the Promotion of Engineering Education.

Respectfully submitted for the Committee by

WM. T. MAGRUDER, *Chairman*
R. I. REES,
G. H. PFEIF,
C. S. COLER,
PAUL CLOKE,
D. S. KIMBALL,
EDWARD C. ELLIOTT,
Committee.

COÖPERATIVE EMPLOYMENT AS A COMPANY ASSET *

By MAX B. ROBINSON

Director of Training and Technical Employment, Cincinnati Milling Machine Company

If our company were asked why we have employed coöperative students continuously for a quarter of a century, since the inception of the system at the University of Cincinnati, our answer must be, "because this coöperation with the University has proven a business asset." The "raison d'etre" is, of course, the trained material which we got out of the coöp. course. Thirty-eight graduates are to-day working full time in our organization, most of them holding responsible positions. About the same number of undergraduate coöps., and in normal times from fifty to sixty, are at work on the half time basis. Together, these constitute 5 per cent of our entire payroll. They come from three separate institutions and work on four, five and six week shifts respectively.

The above makes no mention of the dozens who have had one or more years of coöperative training, but who, for various reasons, did not graduate. The figures are cited merely to show the extent of our own experience with the coöperative plan, since we can only speak for ourselves and not for other employers. The experience has taught us much about the handling of these men. As a net result, it is the feeling to-day among our executives that the coöperative courses are the logical source of material for engineering and supervisory positions.

I take it that a number of you men are college administrative officers or coördinators. You are therefore vitally concerned with problems of placement which, in dark days like the present, are anything but easy. The story of our coöperative experience is probably typical of that of other large employers; therefore, you may be interested in hearing some of the details which involve the employer's point of view.

There are perhaps three distinct phases of the placement question. First, you must sell the prospective employer the idea of receiving coöperative students and of integrating them with minimum friction into the working force. Second, through proper contacts and follow-ups, you must keep him sold in spite of the minor

* Presented at the 39th annual meeting, S. P. E. E., Purdue University, June 17–19, 1931.

annoyances that are bound to creep in. Third, you want a ready absorption of your graduates. To this end, you are concerned with creating among industrial executives a clearer understanding of the potentialities of the whole coöperative arrangement. Through all of your placement relations, you are vitally concerned with the pedagogical soundness of the idea that practice and theory should go hand in hand, the one supplementing the other. You must avoid abuses that lessen the realization of this, and be ready to take advantage of all factors which make it possible.

When you propose employment to a company as yet unacquainted with the coöperative plan, you may begin at the top of the organization and work down, or you may begin at the bottom and work up. That is, you may sell the idea to the high officials first and then, armed with their sanction or with a direct order that such coöperation is to be effected, you deal with the personnel department, the superintendent and foremen. With the opposite plan of attack, you first get the consent of the employment department or the foremen, and after selling them, you follow through with the higher contacts.

As to which procedure is preferable, may depend entirely upon local conditions. For good working results, it is best to sell *all* parties concerned and as an abstract proposition it would seem best to begin at the top where there is a more conscious planning for future personnel needs. This very consciousness invites interest if your proposal is aptly stated. As soon as coöperation is recognized as a company plan, laid down by the management, minor executives will do their part.

As an ideal proposition, most employers and executives are sympathetic with the coöperative philosophy. They will accept the plan provided it can operate smoothly and without friction or opposition from line supervisors. But regardless of theoretical long run advantages, there are few executives who will *force* the plan upon their foremen and department heads in the face of frequent annoyances.

In any manufacturing organization, the aim is to produce quality goods at low enough cost to meet competition and to allow reasonable profit. To this end, there must be discipline, morale and strict supervision in handling minor executives as well as appreciation of human nature and human weaknesses. But few foremen or superintendents are able to attain perfection in their own performance. They are dealing with variables—human and mechanical—which are sometimes difficult to control. When they fall short in their own managerial performance they are usually called to account by higher ups. It is natural, therefore, for the foreman, who has perhaps had unsatisfactory experiences with

certain coöps., to use these as an alibi to condemn the whole co-operative plan within his department. If he has not accepted the coöperative arrangement whole-heartedly and without reservation, it is perhaps only natural to defend his original judgment and to magnify beyond reason the petty annoyances which sometimes come in the process of integrating coöps. into the working routine. This suggests the necessity of selling the coöperative idea to the foreman, regardless of who else has approved it. If the foreman is willing to "play ball," personnel departments and higher ups are usually well pleased. If, on the other hand, friction and complaints are continuously reported, but few employment men and managers will fight this through in addition to their other duties and problems.

But there are other reasons, even in normal times, why the employer may hesitate to take on college students on the part-time basis. First of all, he fears they will not "fit in." They may want special favors, or unconsciously try to avoid the disagreeable tasks. He thinks of the "rah-rah" type, bent on a good time as long as Dad's money lasts—the type so exploited by our cheap press and movies. He fears, moreover, that the alternating arrangement of two men handling one job will inconvenience his foremen or give them too ready an alibi for spoiled work or inefficiency. Perhaps he has heard of the "high mortality rate" in college or of the fact that so-and-so who employed coöps. has never been able to keep any of them beyond the second year. Perhaps he does not express these fears but merely remains non-committal or evasive or declines coöperation because he "already has more employees than business justifies."

As coördinators, you are all familiar with these stock objections. They indicate that the employer is not sold, that he is allowing minor difficulties to blind him to some real advantages. There are many manufacturers of this type, including even those who have given coöps. a cursory trial. While you each deal with them in your own ways, you probably admit at the outset that there are certain inherent inconveniences that cannot be obviated. For example, the coöperative student occasions more overhead expense in proportion to work done than does a full time worker. It costs as much to hire him in, give him the physical examination, place his name on the payroll and the mutual aid rosters, keep records, and to teach him the work, as for a full time worker. The cost of these items for a pair of students, therefore, is about twice what it would be with a full time worker.

On the other hand, after the regrettable mortality of the first year, the turnover of coöperative students is likely to be less than that of full time employees doing the same work. We have often

been glad that different students have rotated on the same job because in the event of sickness of any one, or with an emergency demand for overtime work, it has been possible to call upon some other student in the work shift with this particular training to help out during the emergency. In vacation periods, during peaks of production, it has often been advantageous to allow both men of a pair to double up on the work where extra green help would otherwise have been necessary.

The extra work breaking in the second pair in any given work is often lessened by overlapping two pairs on the same job, allowing the pair that is transferring to another department to break in their successors. The student who can thus teach the details of his work and warn the new man as to the pitfalls, is lessening the work of the foreman and mentally organizing his own recent experience. The extra cost of this overlapping is probably saved by the quicker breaking in of the new pair, and the avoidance of costly mistakes.

The contention that alternating two men on one job imposes extra supervision upon the foreman is not serious if the two men of the pair will overlap on the Saturday mornings preceding the shift. That is, the man coming on duty the next Monday morning spends the Saturday morning with his alternate on the job, and is ready to go ahead on unfinished work without interruption. While this arrangement is not always necessary, at times it is very essential. The students realize this and are usually glad to report for this overlapping without extra charge to the company. Since most coöperative systems now use the longer work period of four to six weeks or more, the inconvenience due to alternations is not what it used to be with the one week shift, which obtained in Cincinnati for six or seven years after the inception of the course.

As to whether coöperative students "fit in," are willing to do the disagreeable tasks and observe the same discipline required of other workers, this depends mostly upon how they are handled by the coördinators and personnel officers. Some fit in and some do not. I believe it is customary for you men to give the student some idea of what he is to expect in the way of discipline and conditions of work before sending him to apply for his job. In our own practice, we build on this preparation at the time of our employment interview. We tell him the hours, company rules as to safety and health, wages, possible wage increases, his probable experience through shop and office departments and in general terms the choice of work he may have upon graduation, should he elect to stay with our company. He is told something of the attitude of our foremen towards coöps., of the necessity for becoming a careful and competent producer as quickly as possible. Both in the first

and subsequent interviews, he is impressed with the desirability of making a good time record under the company's incentive system, both for his own mental development—and the term "mental" is used advisedly—and for the example of others. Since there is physical and material hazard in some of the work, he is taught carefulness and that quantity without accuracy of the prescribed degree is a waste and a loss to himself and to the company. Many of these practices must be explained to the skeptical employer. If he agrees to give the plan a trial, then it is necessary to make good on promises.

In times of depression, the initial placement of coöperative students becomes doubly difficult. There is an excess of workers in nearly all ranks. The desire to maintain the working organization runs counter to the necessity of cutting costs to correspond with decreased income. Short hours and frequent layoffs bring cases of distress and hardship to the personnel officials who are doing their best to make a small amount of work cover a large number of people. Picture also the fact that inefficient workers were probably weeded out early in the depression, the older men with good records of service having been retained, and that any further losses tend to break up a smoothly running machine. The supervisor faced with the necessity for further reductions, puts considerable pressure upon the personnel department to place such workers elsewhere in the organization so they can be returned to their regular jobs when business picks up, thus saving the risk and expense of breaking in untried men. This, in brief, explains the reluctance of the average employment man to add new faces to an organization in times like the present. It explains why many companies pass rules preventing employment of newcomers under which the employment man has no recourse. I know of no formula or suggestions that will help you placement officers overcome these conditions. It becomes necessary, therefore, to approach industries that are seasonally busy, or to find occupations where coöps. will not be thrown in competition for their livelihood with older employees.

This situation gives emphasis to the second major task of the placement and personnel officers—that of keeping coöps. sold once they are employed. The discontinuance of a coöperative arrangement in any company or industry costs money both to the college and to the employer. It leaves a misunderstanding and a reputation which, if uncorrected, is sure to affect relations elsewhere. When relations once started come to an unhappy end, as infrequently happens, it is a reflection both upon the company management and the school. Such a situation is certainly preventable and would not occur if proper contacts and follow-ups were maintained

between the two. The very nature of things seem to assign to the school the responsibility for initiating and maintaining these relationships.

Probably the best insurance of continuous satisfactory coöperation is a real interest on the part of supervisors and personnel men. This can be established in various ways if the coördinator will get the confidence of the foremen and make them feel a part of the "field faculty" of the institution. They will come to know that a college is not always a rich man's school; that the coöps. are a dependable, hard-working bunch who burn midnight oil instead of midnight gas, and who mostly depend upon work weeks for their bread and butter. With adequate interest from the management, they will realize that company prosperity depends upon capable men in engineering and sales positions, and that a self-made man with education and the coöperative experience is preferable to would-be engineers without schooling or to college men whose shop experience has been superficial or hap-hazard. They must realize that company policy—the judgment of our executives—dictates that the coöp. be given a square deal and adequate training and that it is part of their job to coöperate in good spirit.

The coördinator should be as frank and friendly with the foreman as he expects the foreman to be with him. If the foreman is expected to grade the coöp. on his shop progress, he would, in return, be interested in knowing something of the grades attained in college.

Much also depends upon the attitude of the coöps. themselves. The coöp. will sometimes invite his foreman to the open house day at school, to occasional athletic contests, or to engineering meetings. Many a coöp. has helped his foreman over hard places in problems of shop arithmetic or those encountered in evening study and in return receives much out of the experience of the foreman. If such a relationship can be built up out of mutual respect and without patronage, it can have far reaching results in general morale. The fact that twelve per cent of our entire force, not counting coöps., enrolled in regular evening study programs this past year, is not unrelated to the example set by the coöps. in their midst, whose periodical returns to college are always noticed by other employees.

While our foremen are all friendly to the coöps., we would be the last to claim that they were all enthusiastic. Why should they be? A foreman would naturally prefer a steady worker to two alternating workers. He knows that the coöps. are being trained for higher positions in the company and that within the course of a few months, they will be moved on to some other

department, and he will have more green help to break in. The coöp. lives in a different cultural world than does the average foreman and has a different outlook on life. Basically, the two have little in common. In the early days of our coöperation, some foremen looked upon coöps. as direct personal competitors. Since no cooperative graduate, to our knowledge, has ever displaced a foreman with us, that feeling has largely vanished.

I think our foremen and coöps. have attained this state of mutual respect, and any lack of enthusiasm need occasion no alarm. The students know that if they are involved in gross carelessness or breach of discipline, our Training Department will stand by the foreman. The latter knows, on the other hand, that the students must be treated fairly, that occasional mistakes and spoiled work are to be expected and that part of their job is to function as teachers.

In the cultivation of proper internal relations between the coöp. and his supervisors the coördinator must work hand in hand with the personnel man. The school must insist that students observe company rules and discipline and maintain proper attitude toward their work. The employer, on the other hand, must realize that the coöperation is part of a broad educational scheme and that the shop experience of the student, in a general way, should supplement his course of study.

It is doubtful if any day by day coördination of theory and work has ever been attained. That is, the student at work one period does not necessarily encounter the practical application of the theory learned the preceding or following school periods. A nearer approach to the ideal of direct coördination seems to the writer both desirable and possible. An analysis of limiting factors involves problems of school administration and is probably outside the scope of this paper. Nevertheless, is it not true that while responsibility for such coördination has at times been shouldered upon the coördinators their load of urgent placement problems has kept in the background the effort to develop this more direct coordination?

It would seem well, therefore, if engineering instructors themselves could be given this task within their own classes, and to this end were required to spend one or more afternoons per week in visiting the shop environments of their students. What they would learn would give them a greater respect for the system and would greatly strengthen the effectiveness of their teaching. With the aid of the coördinators and personnel men, such visits could easily be arranged.

Sometimes the coördinator, himself, gets the idea that too frequent visits are not welcomed and that an hour's visit twice a year

is better than a shorter visit once a week. While no rules can be laid down governing all cases, frequent business-like contacts between coördinators and executives are desirable. On the other hand, the man who makes a bore of himself by entering a high pressure office and lingers to talk about the weather and baseball (without the proper cue) can do more harm than good. I do not think this is a frequent fault of coördinators, however, because most of them work under as high pressure as the men they are interviewing.

Many coördinators find it possible to mix with employers outside of business hours in social or business club circles. For example, the mechanical coördinator who visits our firm is a member and takes an active part in meetings of our local employment managers club. Others are active in noon luncheon clubs, engineering societies, etc.

The coördinator's problem of keeping the firms sold, is much easier after a few successful graduates have advanced to responsible positions. Because many of our supervisors now handling coöps. are, themselves, graduates from the same course, there is a bond of understanding and sympathy that makes the coöperation more advantageous to both parties. The morale of the student is strengthened by the example of those who have gone before him. His chance at a fair opportunity for experience is increased by the interest of these alumni who realize the pitfalls and possible prejudices within the organization. The company should profit by a lessened turnover of students, a more thorough training of the individual, and a more intelligent placement after graduation.

In evaluating the coöperative experience in our plant, it should be stated that our business is highly specialized along lines of mechanical production. The manual and machine work in shop departments is of a skilled nature, and often requires precision to the "*n*th" degree. The attainment of this precision upon a production scale, involves the development in our engineers of sort of a sixth sense. A man may learn how to get this precision, but he must also learn to let it alone when not needed, for it costs money. The cultivation of this sense of mechanical fineness can only come with practical experience.

With a few exceptions like auditing and accounting, there are no positions in our company for which this foundational shop experience is not essential. I am sure that the same thing is true in many other lines of industry. We therefore require coöps. to spend approximately the first three years in going through the principal shop departments. Here they operate and assemble the machine tools that we manufacture, inspect parts and gain such experience in general manufacturing processes as to form a good

foundation for specialization later on. The students are told at the beginning that at the end of the third year, they may choose between the special fields of shop supervision, sales engineering, laboratory research, timestudy and production planning, and engineering design; and that as far as practicable, their experience during their junior and senior years will be shaped toward the end selected. Hoping to make the best possible selection for himself, the student early becomes somewhat introspective. He sees positions held by coöps. who have gone ahead of him and tries to measure his own capabilities in the light of the requirements of the various types of work. It is our practice to get the coöps. together in groups at intervals and give them general talks about company business, company policy and the opportunities that lie ahead. The Training Director maintains regular office hours for interviewing such students as need special help with their problems.

We are frequently asked as to our wage policy for coöperative students. In this, we conform as closely as possible to the rates paid in the other local shops. It seems to us that money attraction, by paying rates higher than elsewhere, is a false way of holding the better men. At the same time, we do not want to be handicapped by paying less than others. Our starting rate is approximately 36c per hour (33c plus 10 per cent bonus for perfect attendance), with an increase each six months for a successful student. The amount of the raise is either 2c or 3c per hour (plus bonus) depending upon the record the student has made at school and at work. The student who is failing in his studies, or who shows only a mediocre record on the job is given only 2c, while the student who is satisfactory both places gets 3c. The student who is plainly mediocre *both* at school and on the job gets no raise. This usually brings an inquiry from the man and gives us an opportunity to uncover the reasons for his difficulty. The student who continually gets 3c raises per hour finishes his course with a minimum rate of 60c plus the 10 per cent attendance bonus, making 66c in all. The student who gets only 2c raises, finishes his course at 51c per hour base rate, or total of 56.1c. Realization of the possible accumulated difference in rate is quite an incentive to the student both at school and at work. While the foregoing rates are customary, there is nothing in our practice to prevent giving an unusual man a higher rate. We frequently find coöperative students in their senior year drawing $35.00 per week in engineering departments.

One of the obstacles in keeping the employer sold has been the heavy and regrettable losses in the freshman year, involving economic waste alike to student, employer and school. It is not only an expense to start breaking in a freshman coöp. and then have

him flunk out at the end of his first semester, but the annoyance to the foreman lessens his confidence in the stability of all coöps., especially beginners. The result is, that the students must go through the first year before they are taken seriously. In many cases this involves a postponement of the personal interest so necessary to profitable and well-planned experience. Since no way has yet been found to avoid the "high mortality" of the freshman year in engineering schools, the employers would much prefer to have students placed not earlier than the beginning of the second semester, or better yet, at the beginning of the second year. Schools which have changed over to this plan, universally report lower placement costs, better freshman morale and school orientation and infinitely better relations with their employers.

It is frequently asked what happens in a depression to coöperative students already at work. It is just as appropriate to ask what happens to the full time graduates. Either ones are susceptible to the laws of supply and demand. In 1921, the coöperative courses all survived. In that year our plant came to an almost complete shut-down, and most coöps. had to be laid off. We regretted this action in the years that followed. During the present depression, in spite of acute conditions, it has been company policy to retain all coöps. with average ability or better. However, natural losses and turnover have not been replaced, and the total number of under-graduate students on our payroll to-day is thirty-eight (38) as compared with sixty-eight (68) in 1929. Only six students were admitted last fall, three of whom were already in our employ and gave up a full time job, and the other three were sons or relatives of present employes.

Is it right, you may ask, to keep a coöp. on the payroll when so many married men with families are needing the work? Before conditions became acute, our feeling was that the student had a better right to half a job than the average young unmarried employee had to his full time job. After the latter had partly been laid off, and the coöps. came into competition with family providers, they were transferred out of the shops into engineering and office departments as junior draftsmen and clerks. Here they are working at present, mostly away from competition with married men. Because certain departments could not receive them on their payroll, due to reduced budgets, their wages are being carried under a special training budget.

The third problem of placement, namely that of locating the graduates upon jobs, ceases to be a problem if and when the proper interest has been built up and maintained on the part of the employers in industry. Well over half of all coöps. who have graduated in our employ have stayed with our company. If we have

given them the proper training, they are worth more to us than they would be to any other employer. If we do not have openings with opportunity along the lines of the graduates' interests, we are glad to help them locate elsewhere. We believe that such men once established in other firms will maintain a friendly feeling toward us and that potential sales exist in such contacts.

Several months before graduation time, it is decided through executive conferences what students we can keep in the company and what work we may have to offer. The graduating students are then interviewed to invite their consideration of this proposed work. Quite naturally, the student is out to market his services most advantageously and it is not presumptious for him to inquire at once as to the proposed salary. Here we point out the futility of trying to pick a satisfactory line of work on the basis of pay alone. We seek to get from him an expression of his natural attraction for the work itself. We do not want him to come to us for money alone. Unless he believes in the opportunity and has confidence in his own ability to fit in, he had better go elsewhere. At the same time, having had his training with us, he is undoubtedly worth more to us than he would be to some new employer and he is certainly worth more to us than the untrained graduate from a full time school. We tell him this candidly and if he accepts the proposed opening, a starting rate is agreed upon after which future increases are granted on the same basis as to other engineering employees. At no time do we discourage interviews with other employers, because we do not want any graduate to connect with us unless he does so wholly of his own accord and with enthusiasm, ready to throw his energy into the work at hand.

That our continuous employment of coöperative students has proven an asset, may be seen by a glance over the positions in our company now held by coöperative graduates. These include the following: a vice-president, class of 1913; a sales executive, class of 1912; two divisional works managers, classes of 1913 and 1922; maintenance engineer, class of 1923; four estimating engineers, research metallurgical engineer, supervisor of time study department and a variety of other responsible positions in shop, engineering, sales and cost departments.

While this paper has stressed the value of coöperation in our company business, we have tried to keep ever in mind the fundamental concept of the coöperative system, namely, that the arrangement must be mutually profitable, a benefit alike to the student and to his employer. We believe that the endurance of any coöperative arrangement must rest upon this basis. No charitable or philanthropic motive will affect a stable coöperation. Neither would ex-

ploitation. Any coöperative employment that is not mutually advantageous cannot continue for a quarter of a century.

The schools have a wide territory, geographically and industrially, in which to place their men, and in general, the students themselves help decide where they shall work. Their services are marketed under the same laws of suppy and demand that obtain when, as graduates, they go out to seek their own employment. Regardless of whether or not the graduate elects to stay with us, we want him to feel that his coöperative years have been profitable to himself. If he leaves, we want him to leave as a friend and a potential customer.

Looking into the future, we can see perhaps a changed emphasis in our requirements for engineers. Research and the development of new materials and processes will continue, but we have been backward in making economic and social readjustments. The land flows with milk and honey, yet many are in want. With the greatest money wealth in the world, there are many who find credit difficult to secure. With a capacity for enormous production, we suffer from forced under-consumption.

Under these conditions, the engineer must produce at lower costs and with least possible reduction of wages. The major problems of management become problems of economics, of production control, of distribution and of human relationships. There must be more contacts between various levels of workers to increase the bonds of intelligent understanding. There must be built up a jealous concern for our workers' welfare and for his steady employment. There must be an equally widespread respect and confidence in our industrial management. Against these, communism and radicalism could make little progress.

The engineering graduates who are to attain administrative responsibility must more than ever be men of vision, broadly trained. They must apply engineering analysis to these problems of economics and administration, tempered with an appreciation of human relations and group psychology. They will deal with men more than with materials and forces. If our engineers are not prepared to tackle this work they must give way to others with greater adaptibility, but whose basic training may be less appropriate.

In the light of the above, the intimate knowledge of workers and foremen gained by the coöperative student, would seem a distinct asset. To compare the coöperative graduate, however, with those from full time schools is perhaps unfair, unless done on a sufficiently broad scale so that differences in raw material, school personnel and local conditions do not enter. We have excellent men in our company from both sources, but in general, coöperative graduates are two years ahead of full time men in the responsi-

bility they can carry. It is probable, also, that the full time graduate, although willing to begin at the bottom, soon feels economic pressure and becomes too impatient to get ahead to allow mastering the work with the same thoroughness as did the coöp.

It follows therefore that the coöp. has received a better training up to the time he is given responsibility, a training that involved processes, methods, manual skill, discipline and human nature. He is better oriented into his work surroundings because of the opportunities to try himself on different types of work under educational supervision. Without the slightest reflection, therefore, upon the splendid fellows whom we have taken from full time schools, or without any intention of neglecting these schools in the future, the foregoing explains why we consider the cooperative courses the more logical source of our material.

COÖPERATIVE TRAINING IN THE WIRE INDUSTRY

By E. W. KEMPTON

Educational Director, American Steel and Wire Company

In the education of the average young person there should be taken into consideration the probability that he is to spend the greater portion of his life as an employe. He may go far, have unusual success. But the chances are that he will still be an employe. He may find himself the sole owner of a commercial or industrial establishment, but if he is to be successful he cannot be dominated by self interests. He must adjust his policies and practices to conform to the opinions and desires of his market, which does not remove him instantly from a status resembling that of an employe.

Although this fact is recognized, not much is done about it as a general rule. That youth goes through a period of adjustment, of acclimatization, after his recruitment to the ranks of employes, is well known, and the ensuing problems recognized, but as a usual thing a policy of laissez faire is adopted. What can be done about it—nothing—let him alone—he'll soon settle down and get used to working for a living—that's the trouble with young people, they don't want to work—they don't know how to work.

Who has not heard these statements and others, not alone about the college man, but about youth in general? The problem is not easy—neither is the transition from the carefree (relatively) life of a high school or college student to the acceptance of the responsibilities of an employe, or what is more important, the fulfilling of the expectations of an employer. The problem is double edged.

There is a feeling among executives that education is, for some reason or other, not greatly interested in the problems created by the fact that most people must work for a living, and for somebody else. This is not true, of course, for never in educational circles has there been a greater consciousness of the need for vocational counsel and guidance, for vocational preparedness, than at present. Probably more educational research, from a quantitative point of view, is directed along this line than any other, perhaps than all others put together. However, results are for the most part, painfully slow in appearing.

Industry requires a constant addition of young men, not a large number each year, but a steady flow to take care of replacements

and of future requirements. Industry is largely technical and since most young men who are industrially inclined take technical courses, the graduates of technical schools make ideal recruits where it is hoped that the individual will make progress with the organization. If, in addition to his school training, the recruit has had sufficient industrial experience quickly to fit into the scheme of things, the combination is ideal. This combination is provided in the graduate of a coöperatve course.

The American Steel and Wire Company has for some time recognized the value of coöperative training. Here is an opportunity for a combined educational and training effort, the school does its part of the job, and from his work in the plant, with some counsel and guidance, the young man acquires a knowledge of the process and material of the wire industry. He becomes accustomed to rubbing elbows with other workers. He learns that industry is a coöperative effort.

In 1931, five of these young men graduated with their engineering degree and with five years' practical experience in some phase of the wire business. Each one of these men will undoubtedly do well. Unfortunately the present business situation has interfered with their continuity of employment. This, however, is but a temporary setback.

Such a combination training is of value to employers. But why not set about to reap the most of such a process? So frequently an employer is faced with the problem of a capable, industrious, intelligent young man, who for one reason or another, failed to obtain sufficient formal education. This young man would be of more value to his employer and to himself had he some, or more, technical training. His attention should be directed to the possibilities of the coöperative method whereby he would be able, through part time employment, to continue his education.

The American Steel and Wire Company has done this with desirable results. A description of the coöperative method was printed and distributed through the Employment Department to young men who had attracted attention. Parents, executives, and employers who had not learned of the method thus became familiar with it. The response was encouraging. Each applicant and his parent were interviewed. Attitudes were studied, complete information and advice were given. The Company made no contribution except to agree to furnish employment upon a part time basis under the same conditions offered to other types of apprentices.

Unfortunately the business depression has interfered with the plan, and curtailed progress, but sufficient evidence of its value had already appeared by 1930.

There is a tendency to measure education by grouping individ-

uals into grade school graduates, high school, and college graduates. Let a young man state that he spent two years in college and then dropped out, and there is somewhat of stigma attached, something of a feeling that he had started something that he did not finish. This should not be the case. Education is a full lifetime process and if a boy can spend but one or two years in college, he ought to be better equipped than without any. Even though he is dropped out because of his failure to attain certain standards of accomplishment, he should still be better off for the influences to which he has been exposed.

Therefore, it is not considered that the purpose of the plan has failed because not all of these young men will go on to graduation.

As an illustration, consider the case of a young man with two years of high school training. He applied for and was given employment as a machinist apprentice in a four year apprenticeship course. He completed this course with credit to himself and with high recommendations from his foreman. Because he had become twenty-one years of age or more, the University admitted him as a special student upon the basis of his age and the recommendation of his employer, in lieu of high school graduation. He completed two years of coöperative engineering training when he was compelled to quit school. The reason for his quitting is of more theoretical value than practical and is usually considered important only by personnel men and not by practical executives. He has increased his fund of scientific information. He has been introduced to the scientific method of thinking. Measured in terms of years of education, he has one-half an engineering degree and is one-half an engineer. Measured in terms of education plus experience, plus the amount of stamina that he had to possess to go through this process, and he undoubtedly will be of value to his employer, to himself and his community.

So the coöperative school has at least two points of value to employers. It serves to introduce the student into practical life, to orient him, to eliminate that rather embarrassing period when he is more of a liability than an asset, while he is still a student and so considered by everybody. Then it provides an instrument of training for those who would be of greater value to the organization with either a partial or a full technical college course. These factors make the plan worth consideration to the executive. The advantages to the student and to the process of education are also of considerable value and in turn have a reflected value to the employer.

SOME PHASES OF THE HISTORY OF CHEMICAL ENGINEERING*

By WALTER L. BADGER

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Since chemical engineering has been recognized as a separate division of knowledge for only a few years, it would seem that there would be very little to write in connection with its history. When one begins to investigate, however, he finds that this particular field of knowledge has been recognized as a separate one for a long time, and that many of the operations included under chemical engineering are older than written history.

The idea that chemical engineering consists of a knowledge of the "unit operations" is generally supposed to have originated in the Little report of 1922.† The well-known textbook of Walker, Lewis, and McAdams is also generally considered the first to discuss the unit operations. Kirkpatrick,‡ however, has pointed out that in May, 1880, a group that was about to form a new society spoke of chemical engineers and defined them as follows: "A chemical engineer is a person who possesses chemical and mechanical knowledge and who applies that knowledge to the utilization on a manufacturing scale of chemical action." It was suggested that the name of the society be changed to "Society of Industrial Chemists" instead of "Society of Chemical Engineers" because it was felt that the word "engineering" or "engineers" would eliminate the proper emphasis on chemistry.

However, I believe that there is a much older definition of chemical engineering, and an older list of the unit operations, than anything that has been cited so far. In 1572 the famous physician, Dr. Phillipus Aureolus Theophrastus Paracelsus Bombastus Graf von Hohenheim published a little book called "von natürlichen Dingen" of which the seventh book was entitled "de Transmutationibus." Now, to Paracelsus, "transmutations" covered all or-

* A lecture delivered before the Chemical Engineering session of the Summer School for Engineering Teachers, University of Michigan, June 25, 1931.

† Report of the committee on Chemical Engineering Education, Am. Inst. Chem. Eng.

‡ Address before the Student Conference at the Chemical Exposition, May, 1931.

dinary chemical processes, together with some that we would class nowadays as purely physical. He defines them as follows: "Now transmutation is that a thing shall lose its form and appearance and be changed. That is, that it no longer appears like its original substance and form but takes upon itself a different form, a different substance, a different being, a different color, a different power, a different nature or property. As, for instance, when a metal is changed into a glass or stone (slag or oxide), a piece of wood becomes a stone, a stone becomes coal, clay becomes stone or bricks, leather becomes glue, cloth becomes paper, and many more of the like. These are all the transmutations of natural things."

The field that Paracelsus has marked out is the whole field of chemical industries as we know it today. However, in the light of our modern insistence that all chemical processes are made up of a few unit operations, mark what Paracelsus says: "Now it is highly necessary to know the degrees and steps of these transmutations and how many they may be. Such steps are no more than seven, although some persons count many more. This, however, is not true, for the principal degrees of transmutation are but seven and the others which might be counted separate degrees are included under these seven; and the seven are as follows: Calcination, Sublimation, Dissolving, Putrefaction, Distillation, Coagulation, and Coloration. Whoever now shall ascend and pass these seven steps, he shall see and experience many secret things in the transmutations of all natural substances." Paracelsus cites several subdivisions of these unit operations; but in the rest of the book in which these operations are discussed particularly, no attention is paid to the subdivisions and the discussion is limited to the theory, practice, and equipment necessary to carry out the seven major unit operations.

Interesting as it may be to trace the history of ideas, it is much easier to trace the history of things; and so although this line of thought might be extended, the rest of this paper will be devoted to tracing a history of some of the unit operations and the equipment used for them.

The Transportation of Liquids

Leaving out of consideration open channels of earth, stone, or planks (which have been used from the earliest times), the existence of some sort of pipe is necessary for the transportation of liquids. The history of pipe is in itself a long and complicated one.*

* Much of the material in this section is taken from the general catalog of the U. S. Cast Iron Pipe and Foundry Company, and Bulletin 11F of the National Tube Company.

The oldest known piece of metal pipe is a drain that led from the altar at the tomb of King Sahuré of the Fifth Dynasty (about 2900 B.C.). The Fifth Dynasty covers those kings of Egypt who followed immediately after the builders of the great pyramids in what is known as the Old Kingdom, the first organization that appears definitely in Egypt. This pipe was made by rolling a sheet of copper around a mandrel and hammering its edges together. The individual sections were about 40 inches long and 3½ inches in diameter. They were made slightly tapered so that the small end of one would fit into the large end of the other, but there is no evidence of any packing.

Since the burning of clay into bricks and pots has been known from the very earliest times, it is not surprising to find that stoneware pipe was made almost as long ago as this piece of copper pipe. Stoneware pipe is found in the excavations in Babylonia and Assyria, in Greek and Roman ruins, and in many Roman villas of the later parts of the Empire all over southern and central Europe. The earliest specimens were unglazed, but later a salt glaze was used. Many specimens have well defined bell and spigot joints. The Greeks used stoneware pipe with cast lead in the joints. I have a piece of chemical stoneware pipe made in the United States about 1908 that shows scarcely any improvement in design or workmanship over late Roman pieces. A side light on the use of stoneware pipe for plumbing that is not ordinarily appreciated is that in the palace of Cnossus in Crete, which dates from the third millennium B.C., there was a complete sanitary system, including flush toilets supplied by rain-water tanks on the roof, with all the drainage carried in concealed plumbing stacks.

During the Roman Empire the principal type of pipe used was lead pipe. This was made by rolling or hammering lead into sheets, bending it over to make an oval tube, and soldering the edges together. The nominal size of the pipe was the width of the sheet before rolling. The architect Vitruvius, who wrote a handbook of architecture in 25 B.C., gives ten standard sizes of lead pipe ranging from 5 inches to 100 inches. The standard length was 10 feet. Not only were the sheets cut to a standard size, but the weight of the sheet was also standardized so that Vitruvius was able to give the standard weight per section for each size.

During the Dark Ages it is practically impossible to follow the history of engineering and the arts. As Europe emerges from the Dark Ages we find that the commonest type of pipe is wood pipe made by boring out logs. Fig. 1 * shows the method by which this pipe was cut. In the background a log can be seen tied to a

* Agricola, "De Re Metallica."

FIG. 1. *A*, sump; *B*, pipes; *C*, flooring; *D*, trunk; *E*, perforations of trunk; *F*, Valve; *G*, spout; *H*, piston-rod; *I*, hand-bar of piston; *K*, shoe; *L*, disc with round openings; *M*, disc with oval openings; *N*, cover; *O*, this man is boring logs and making them into pipes; *P*, borer with auger; *Q*, wider borer.

framework while a workman bores it out with a hand auger. Two of his augers (P and Q) are lying on the ground beside him. When it is recalled that such pipe often had a bore greater than 6 inches, and was made from such hard woods as beech, maple, and oak, a little idea of the strength necessary to bore such logs can be obtained; especially by any one who has ever attempted to drive a carpenter's 1 inch auger-bit into the end of the grain. This type of pipe was generally used in all engineering operations up to about 1800. Many samples of wood water pipe laid in the United States up to 1810 or 1820 have been recovered and are in various collections.

During this period several attempts were made to use metal piping for city water works services. Cast-lead pipe was laid in London between 1235 and 1285, but most of it was destroyed in the Great Fire, and lead was not again used. The first well-authenticated use of cast-iron pipe was to supply water to the fountains of Versailles. This was laid between 1664 and 1686. Cast-iron pipe did not appear in the United States until 1817, but in the next 25 years largely displaced wood pipe.

Wrought iron or steel as pipe is relatively recent, but all through the Middle Ages steel skelp was welded into tubes exclusively for gun barrels. At the close of the Napoleonic Wars, gun barrels were so plentiful that the first company to manufacture gas in London used for its distribution system pipe made of old gun barrels threaded and screwed together.

In 1812 Osborn patented a mechanical trip hammer for lap-welding tubing. In 1824 Russel patented a combination of a mechanical trip hammer for butt-welding, with rolls and a mandrel for finishing the tubes. In 1825 Whitehouse patented the drawing of butt-welded pipe practically as it is carried out today. This process was first used in the United States in 1830 to 1831. I have not been able to find a definite date for the introduction of the lap-weld process as it is used today for the majority of pipe.

In a book, published in 1778, entitled "Beitrag zur Aufnahme der Salzwerkskunde," Carl Christian Langsdorf discusses the bursting strength of pipes. He had no figures for the actual tensile strength of his materials, so his formulas had to be comparative only. He gives, as a basic formula:

$$d = r\left(\frac{\sqrt{2\,a\,P\,D\,(R+\tfrac{1}{2}\,D)}}{A\,p\,R^2}+1\right)-1$$

in which

D = wall thickness of a pipe of known strength,
A = safe working pressure in ft. of water for known pipe,
R = inside radius of known pipe,

P = strength of material of known pipe,
d = wall thickness of unknown pipe,
a = safe working pressure, unknown pipe,
r = inside radius, unknown pipe,
p = strength of material, unknown pipe.

Langsdorf also solves this same equation for a and for r. Since these formulas can only be used when the strength and safe working pressure of some one pipe is known, he gives the following data:

For metal pipe.

A lead pipe, 12 inches inside diameter, with a wall 0.5 inches thick, is safe for a working pressure of 60 ft. of water. The values to be used for p are:

Lead	1.0
Copper	10.3
Iron	15.3

For wood pipe.

A pipe bored from a fir log, with an inside diameter of 4 inches and with a wall 0.5 inches thick, is safe for a head of 5 feet of water. The values to be used for p are:

Fir	1.00
Alder	1.66
Oak	1.91
Beech	2.08

From these data Langsdorf solves such problems as this: An oak log is 18 inches in diameter. How large may the bore be if the pipe is to stand a head of 125 ft.? (Ans. 6.24 inches.) He also gives the cost per cubic foot of different kinds of wood, and the cost per foot of boring different sized pipe from different woods, so that a calculation may be made of the economic balance between the increased cost of boring the harder woods, and the decreased cost of the log because of the thinner wall necessary when using the harder woods. All of which is pretty satisfactory chemical engineering for 150 years ago!

Pumps

The oldest form of mechanical device for lifting liquids was probably the shaduf, or multiple well sweep. This was used in Egypt and in Babylonia from the earliest times. Another very ancient form of water lifting device was a large under-shot wheel with jars or buckets arranged around the periphery in such a manner that they filled with water when submerged at the bottom of the wheel and discharged into a trough at the top of the wheel.

This form was used continuously up to the seventeenth or eighteenth century.

The Greeks and Romans both knew the rag pump. This consists of a chain passing up through the center of a pipe and carrying balls or bundles of rags at intervals. These form pistons which carry water up through the pipe and discharge it at the top. This type of pump also was used for many centuries, and is regularly mentioned in engineering writings of the sixteenth and seventeenth centuries. A cast-bronze force-pump with metal valves has been found in some late Roman excavations. This pump was not greatly different in either construction or operation from an ordinary piston pump of today.

One of the earliest writers to describe engineering devices in detail was Agricola. In his "De Re Metallica," published in 1556, he describes several different types of pumps. Fig. 1 (which shows the manufacture of wood pipe also) shows the construction of a single-stage single-acting piston pump. The construction of a foot valve is shown at *D*. A variety of constructions of piston are shown, some of which employed a cup leather *K*, and others employed flap valves. *L* and *M* are pistons of different construction, some of wood and some of metal; and *N* is the leather disc that formed the valve. Several partly assembled pistons of both types are shown in the figure.

It is curious that not only Agricola but other later writers on engineering were not particularly analytical in classifying the apparatus they described. For instance, Agricola describes what he calls "seven different kinds of pumps." The pump part of all of them is identical with the pump of Fig. 1, and they differ only in the mechanical elements used to operate them. Space does not permit showing them all, but Fig. 2 shows a duplex 2-stage piston pump driven by a water wheel. Other pumps shown by Agricola involve various combinations of levers and motive power, but the pump itself remains a single-acting piston. Fig. 3 shows a rag pump.

Captain Ramelli, who was engineer to Louis XIV, wrote a book on engineering entitled "Le Diverse et Artificiose Machine" in which he describes over 100 different pumps. As with Agricola, most of these are merely different methods of operating a very few kinds of pumping mechanisms. Fig. 4 is one of Ramelli's pumps in which the pistons of four single acting pumps are operated by a mechanical device, of which Ramelli was very fond, for obtaining reciprocating motion from uniform rotary motion. The water wheel in the bottom of the tower drives the central vertical shaft on which are two bevel gears *D*. The upper one has teeth on the left hand half of its circumference only, and the lower one, which is almost

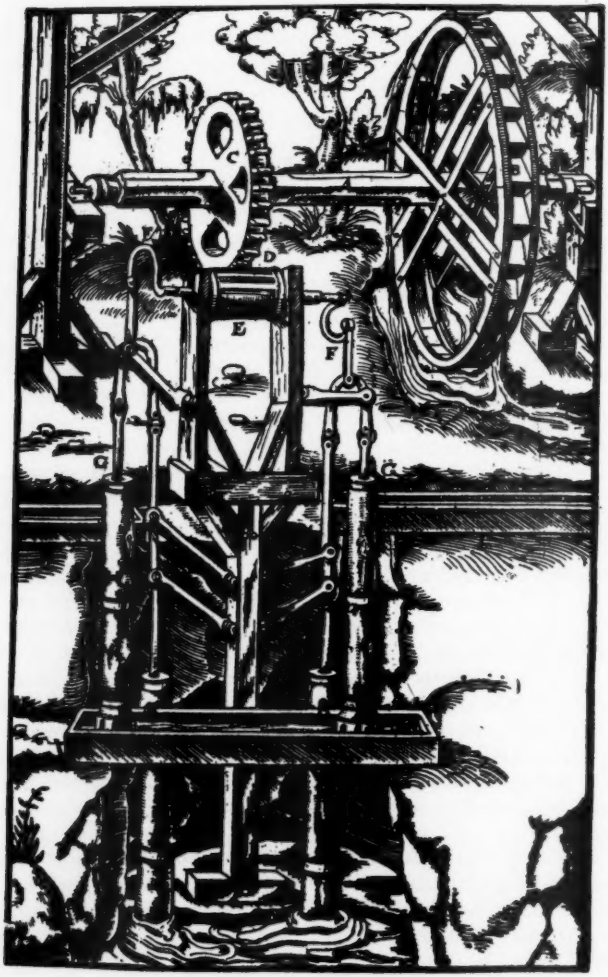

FIG. 2. *A*, upper axle; B, wheel whose buckets the force of the stream strikes; *C*, toothed drum; *D*, second axle; *E*, drum composed of rundles; *F*, curved round irons; *G*, rows of pumps.

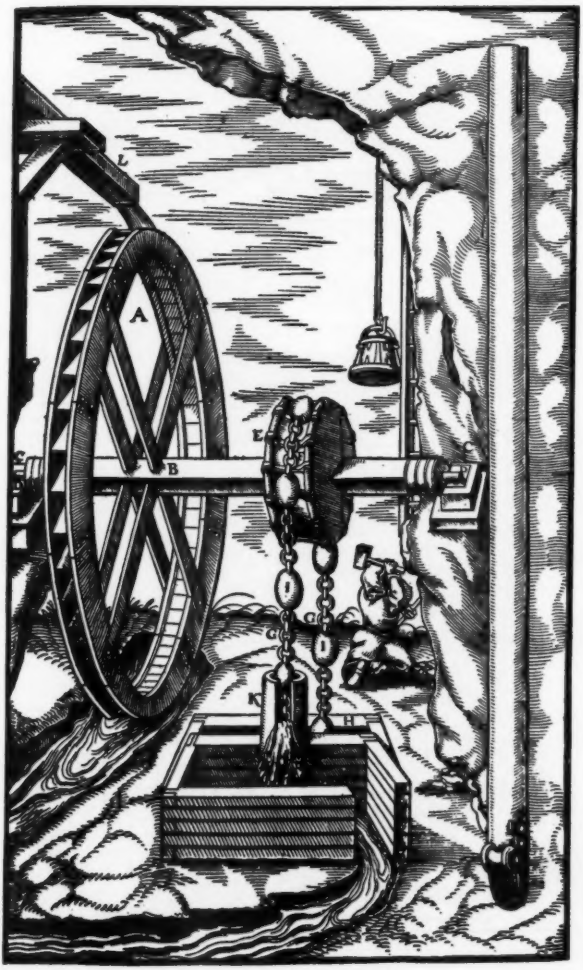

FIG. 3. *A*, wheel; *B*, axle; *C*, journals; *D*, pillows; *E*, drum; *F*, clamps; *G*, drawing-chain; *H*, timbers; *I*, balls; *K*, pipe; *L*, race of stream.

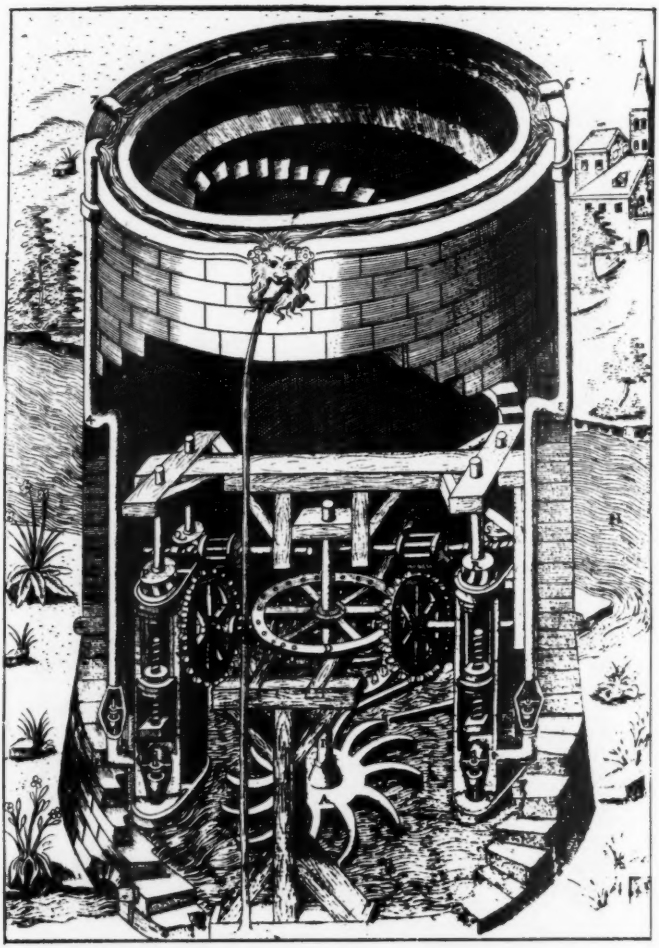

FIG. 4.

hidden, has teeth on the right hand half of its circumference only. These teeth engage the pinions of the two intermediate shafts and thus these shafts are rotated first in one direction and then in the other. The gears on these intermediate shafts drive the pinions on the upper horizontal shafts, which in turn, by means of worms and worm wheels, rotate sleeves in the upper part of the pump cylinder proper. These sleeves screw the pistons up and down by engaging the threads of the piston rods. Fig. 5 is another of Ramelli's pumps using the same drive mechanism. The large piston *N* works in a cylinder so big that it requires four inlet valves and four discharge pipes. Fig. 6 is another rather curious drive showing a single-stage single-acting reciprocating pump. In Ramelli's book there are probably 90 variations of these different drives on the same type of pump.

Ramelli was not limited entirely to reciprocating pumps however. He shows rag pumps, water wheels, and various rotary positive pressure pumps. Fig. 7 shows a pump which is practically identical with the Taber pump of today.

In the further development of pumps it is surprising how little change has been made in the construction of the water cylinder, the piston, and the valve mechanisms. The introduction of steam power merely gave a wider scope to pump builders, but did not change the designs they used for the water end. In fact, Henry Worthington's invention of the duplex pump in 1859 really affected only the steam end, and left the water cylinders approximately as they had been 300 years before.

The principles of the centrifugal pump were known to Ramelli, but for a long time it remained an inefficient and impractical pump. The development of the centrifugal pump was so slow and so gradual that it is difficult to point out any particular date worthy of mention. However, the centrifugal pump as we know it today, both volute and turbine, is largely the result of the work of the Sulzer brothers in the 90's.

Other engineers may raise the objection that the discussion up to this point has been a discussion of a phase of the history of engineering in general rather than of chemical engineering. This is perfectly true. Although the transportation of liquids is one of the vital unit operations which the chemical engineer must always employ, it is not peculiar to this field. The history of these two phases of chemical engineering has been given in some detail because the more general use of these unit operations has left more information and therefore the material is easier to find. The succeeding paragraphs will discuss some unit operations that fall more particularly in the chemical engineer's field.

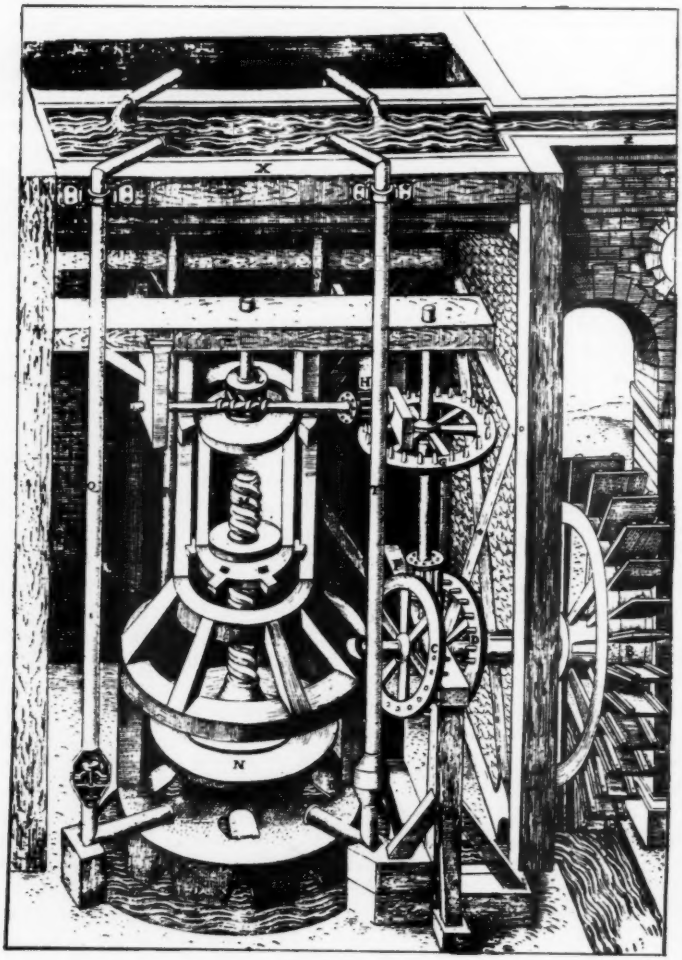

FIG. 5.

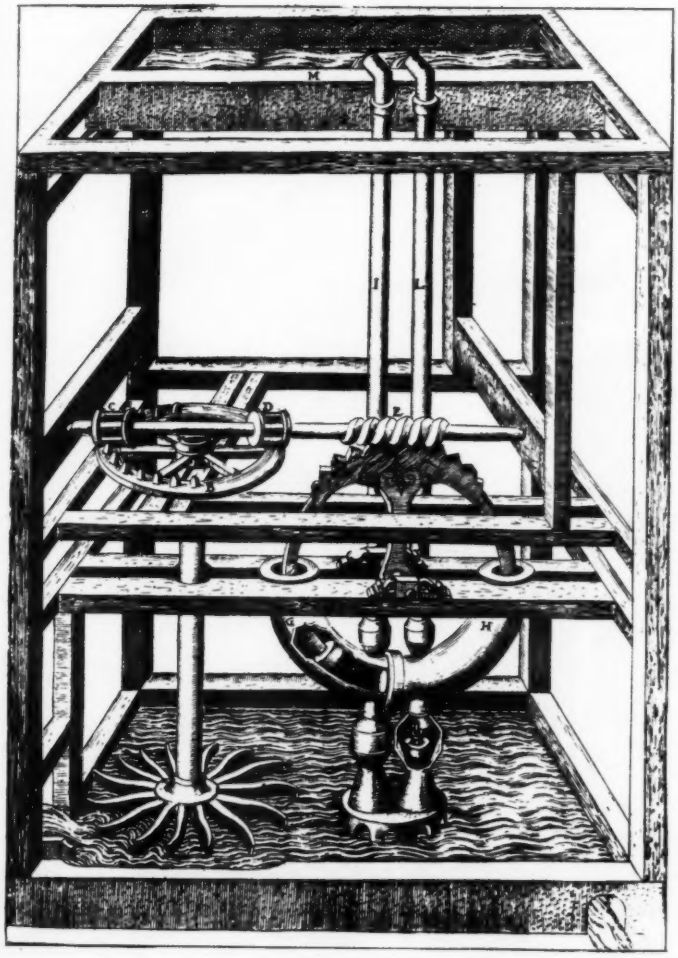

FIG. 6.

FIG. 7.

Heating and Evaporating

This operation is one which also falls into the field of engineering in general, but its later developments will be confined to the special developments found in the field of chemical engineering. Evaporating in pots over open fires has, of course, been known since the earliest times. The water bath, as a method of gradual evaporation at low temperatures, was ascribed by the early alchemists to Maria the Jewess, an alchemist of the First Century A.D. This is the origin of the French term for the water bath "bain-marie." Actually the water bath was certainly known to Democritus at least 500 years earlier.

The early alchemists used for low temperature heat not only the water bath and sand bath, but they also packed the apparatus in warm ashes. Another very common source of low temperature heating was to pack the apparatus in fermenting manure.

The first laboratory hand-book of pure and applied chemistry was "Das Buch der Distillation" published in 1517. The alchemists did not distinguish between distillation and evaporation, so that much of the apparatus of this book is really evaporating ap-

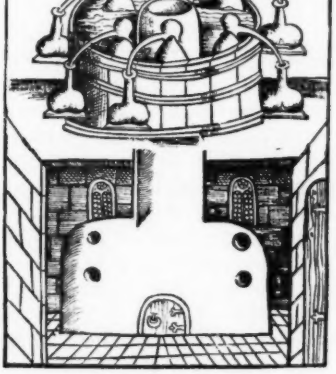

Fig. 8.

paratus. Fig. 8 shows a furnace for evaporation on a large scale in a water bath. The difficulties of perspective were evidently too much for the artist, but it is plain that there was a large furnace on the ground floor, and on the floor above was a large tub containing water through which the stack of the furnace passed. In

this water were placed the evaporating vessels and outside the tub were the receivers for condensate. This book contains many other figures of furnaces for large scale evaporation, but they do not differ appreciably from the one shown.

I have not been able to find any definite date for the first use of steam as a heating medium. Although until about 1800 the commonest method of heating was by direct fire, it nevertheless appears that by 1800 the use of steam in coils and in double jackets was well known.

The first radical step in the development of modern evaporating apparatus was taken in 1812 when Howard invented evaporation under vacuum. Howard's original vacuum pan used a steam jacket for heating and a device that was a combination of surface condenser and barometric jet condenser. This was immediately adopted in all the English sugar refineries, but found little popularity on the Continent, apparently because of the large size and unsatisfactory performance of the air pumps needed.

The invention of the multiple effect evaporator is a point over which there has been considerable controversy. The French usually claim the credit on the score of an apparatus described by Pecquer, which certainly contains the principles of multiple effect operation. This was patented in 1834 but the apparatus, so far as is known, was never built and certainly was not practical. It operated entirely above atmospheric pressure. Péclet in 1828 pointed out the principle of multiple effect evaporation, but did not understand the use of vacuum; and so far as is known no apparatus was ever built as a result of Péclet's suggestions. Norbert Rillieux, a native of New Orleans, was living in Paris about 1830 and working on various engineering projects connected with sugar manufacture. It is stated that at this time he conceived the idea of multiple effect evaporation under vacuum, but he built no apparatus at this time and the evidence is decidedly indirect. He returned to the United States somewhat later, and in 1843 built and operated the first multiple effect evaporator on a commercial scale, with the later effects under vacuum. This was covered by U. S. Patent 3,237 of August 26, 1843. It was a horizontal tube evaporator having four bodies operating as a combined double and triple effect. The first three bodies made a triple effect. The fourth body was also under the final vacuum, but was heated by steam from the first so that the apparatus could in no sense be called a quadruple effect evaporator. It is curious that all the machines that Rillieux built, and those of his immediate successors, included this feature, so that in every case the number of effects was one less than the number of bodies.

About 1850 Cail et Cie. began to build vertical tube evaporators

and, according to Horsin-Deon, the design was furnished by Rillieux. However, credit for the standard vertical tube evaporator is usually given to Robert, Director of the beet sugar factory at Seelowitz. Whether or not Robert really invented the vertical tube evaporator is not clear, but it is certain that Robert built the first standard triple effect; and, in fact, the first multiple effect evaporator in which the number of effects was equal to the number of bodies.

Robert's vertical tube evaporator was the standard until 1879 when the Wellner-Jelinek horizontal tube evaporator appeared. The original drawings of this are practically identical with many horizontal tube evaporators now in operation in the United States. This type had a wide popularity in Europe for a number of years, but later lost favor in Europe and is not common on the Continent. It has always been the popular type in the United States up until a relatively few years ago. In general, however, it is almost obsolete at the present time.

During the period from 1875 to 1890 the literature of the beet sugar industry is full of patents on evaporator modifications, some of which, like the Kestner are still being used, some of which like the Lillie and the Yaryan had a vogue for a while and then disappeared, but most of which never existed except on paper. From that time to the present development has been very slow and has consisted mainly of the elimination of various types with interest concentrated on the perfection of not over three types of evaporators; namely, the standard short-tube vertical, the long-tube natural circulation vertical, and the forced circulation vertical.

DISCUSSION OF PROFESSOR EDWARD V. HUNTINGTON'S PAPER ON "TEACHING THE CALCULUS"

By LOUIS O'SHAUGHNESSY

Virginia Polytechnic Institute

At the beginning of his paper Professor Huntington refers to the bete noir of all college curricula, that is, the question of saving time. If we had enough time practically all of our troubles would be ended.

The clash between the use of a theorem and its demonstration is the old one of the handbook versus theory. There should be enough rigor to teach the methods of exact reasoning, but not so much as to lose the student in a philosophical haze.

Explanations of the differential and the derivative are clear and concise and need leave no one puzzled; while the illustration of velocity "at the instant" is particularly fine.

The geometric definition of the differential as that value which $\triangle y$ would have if the slope of a curve suddenly became constant at the point in question, seems to me to be very near to the theory of limits—since the slope of a curve is the value of the derivative at that point.

The logical development of the rules for differentiating is very good and I believe should make the student understand the processes without any difficulty. Professor Huntington's method of building up the exponential function and then the logarithmic function should be helpful, especially later on in problems involving many types of natural phenomena.

It has always seemed to me to be advisable to give a geometric interpretation to the hyperbolic functions—that is, to explain their line values somewhat as we explain the line values of the circular functions.

It is made very clear that functions of two or more variables need cause no trouble. The illustration in connection with a tangent plane is an extremely good one.

When Professor Huntington discusses formal integration, his paper should please everyone. His supplementary theorem is like a "squeeze play"—and a very convincing one too.

Successive integration like successive differentiation should be easily understood if the student will only remember that *not all limits* are constants. Variable limits are the greatest source of difficulty for most students.

The development of the algebra of complex quantities is very interesting. There is little need for worry over $\sqrt{-1}$. It has been said that Steinmetz developed the theory of the alternating current around this "imaginary quantity."

Professor Huntington's paper will be helpful in classes in mathematics and also in classes in mechanics. Already I have had occasion to refer to it in some of my classes in mechanics. It is a distinct contribution to the teaching of the Calculus both to the student in mathematics and to the student in general engineering. Those of us who heard the paper at Minneapolis had an additional advantage, while enjoying its presentation, because of the pleasing personality of its author.

By WILLIAM J. BERRY

Brooklyn Polytechnic Institute

Any pronouncement by Professor Huntington on the teaching of mathematics must be received by his colleagues with interest and respect. One may not always agree with him, but what he has to say is sure to be thought-provoking and stimulating. His addresses last summer before the Summer School for Teachers of Mathematics at the University of Minnesota were no exceptions. His subject, "The Teaching of the Calculus," is one of vital concern to every university and engineering school teacher of mathematics.

It is generally supposed that no subject in mathematics gives greater trouble to the student than does the calculus, and this opinion is shared by the students themselves. My own experience leads me to believe that much of the difficulty is caused by faulty preparation and the resultant inability of the students to perform the ordinary operations of algebra with ease and accuracy. Even though this be true, it is nevertheless necessary to present the new ideas fundamental to the calculus with care and clearness if the student is to understand what it is all about.

With much of what Professor Huntington has to say I find myself in hearty agreement. The necessity for saving time, the distinction between the use of a theorem and its proof, the elimination of long and involved discussions of topics for which the student can see no possible use, are all excellent points for the teacher to keep in mind. Professor Huntington's insistance upon the basing of all applications of the theory of definite integrals on fundamental principles and the avoidance of numerous formulas is sound pedagogy and should appeal particularly to teachers of engineering students. We want, at all costs, to avoid turning out "formula

engineers." "The fundamental theorem and a little common sense is all that is needed for any of these problems." "All he has to do is to keep his eye on the figure and write down the answer." The whole philosophy of the application of definite integrals is contained in these two sentences. Incidentally it should be noted that the teacher himself requires no small amount of this same common sense. One cannot fail to be impressed by the large amount of material Professor Huntington has succeeded in putting into the course through skillful ordering of the presentation.

It seems to me, however, that the topic of complex numbers might properly be treated in a course in algebra, thereby saving time for other work in the calculus. My own students, when they come to the calculus, are fairly familiar with complex numbers and have, indeed, been using them in courses outside the department of mathematics. I should make something of the same sort of criticism with regard to the amount of time devoted to the introduction of the exponential function. If exponents have been correctly taught in the course of algebra, the student knows that the answer to the question "What does it mean to multiply a number by itself n times? ($\frac{3}{4}$ of a time or -7 times) is "Not a thing." Of course if this sort of preliminary training cannot be predicated, it is essential to include it in the course in calculus.

There are times when I suspect Professor Huntington of tilting at windmills, or, to change the figure, of concentrating his heavy artillery on non-existent targets. Like most of us, he occasionally rides his hobby a bit hard. I rather fancy, for example, that his presentation of the topic of differentials is not very different from that which most of us use, and that "successive approximations to zero" do not figure in our discussions. Nor do I believe that the average student is as much worried about the "ghost quantity" as Professor Huntington thinks he is. I should hesitate to indulge in the elaborate playfulness which he employs in building up the theory of the complex number.

But these, after all, are very minor criticisms, dependent, in a measure, on the sequence of courses in a particular curriculum and upon their individual content. Teachers of mathematics everywhere owe a debt of gratitude to Professor Huntington for having so clearly and forcibly differentiated the essential from the non-essential, for having indicated where the emphasis properly belongs, and for having so deftly integrated his various elements into a comprehensive and useful whole.

NEW MEMBERS

BUCKINGHAM, EARLE, Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. F. Alexander Magoun, W. H. Timbie.

CLEARY, STEPHEN F., Instructor in Drawing, Cornell University, Ithaca, N. Y. H. Liederichs, C. E. Townsend.

HOMERBERG, VICTOR O., Associate Professor of Physical Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. F. Alexander Magoun, W. H. Timbie.

LEWIS, WARREN K., Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Dugald C. Jackson, W. H. Timbie.

MCADAMS, WILLIAM H., Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Dugald C. Jackson, W. H. Timbie.

WALLS, JOHN A., Vice President and Chief Engineer, Pennsylvania Water & Power Company, 1611 Lexington Building, Baltimore, Md. Dugald C. Jackson, B. F. Groat.

BOOKS AND AUTHORS

We are desirous of making the list of authors who are members of the S.P.E.E., a preliminary list of which was published in the March JOURNAL, as complete as possible. A supplementary list will be published in the June number of the JOURNAL. If you are an author of an engineering text or reference book, please send to the Secretary's office the following information:

Exact name of author;
Title of book;
Complete name of publisher.

MEMBERS IN ENGINEERING SCHOOLS AND COLLEGES

Institution	Members Nov. 3, 1931	Applications Received after Nov. 3, 1931
Akron, Univ. of	9	
Alabama Poly. Inst.	13	
Alabama, Univ. of	2	
Alberta, Univ. of	3	
Antioch College	2	1
Arizona, Univ. of	8	
Arkansas, Univ. of	11	
Armour Inst. Tech.	27	
Beirut, Univ. of (Syria)	1	
Bombay C. E. College	1	
Bradley Poly. Inst.	2	
Brazil-Poly. School of State	1	
British Columbia, Univ. of	4	
Brooklyn Poly. Inst.	21	
Brown Univ.	9	
Bucknell Univ.	13	
Buffalo, Univ. of	1	
Butler Univ.	1	
Calif. Inst. Tech.	8	
Calif., Univ. of	15	
Calif., Univ. of So.	6	
Carnegie Inst. of Tech.	14	1
Case School of Applied Science	29	
Catholic Univ.	1	
Cincinnati, Univ. of	6	1
Clarkson College	8	
Clemson College	10	
Colby College	1	
Colorado Agri. College	6	
Colorado School of Mines	10	
Colorado, Univ. of	19	2
Columbia University	28	1
Connecticut Agri. College	1	
Cooper Union	14	
Cornell University	28	1
Cornell College	1	
Dartmouth College	4	
Dayton, Univ. of	6	1
Delaware, Univ. of	8	
Denison Univ.	2	
Denver, Univ. of	1	
Detroit University	14	1
Drexel Institute	8	
Duke Univ.	7	
Duluth Jr. College	2	1
Ecole Polytechnique	7	
Ely Jr. College	1	
Escuela Centrale de Ing. Ind.	1	
Evansville College	3	
Fenn College	12	
Florida, Univ. of	7	
Franklin and Marshall	1	
Franklin Union	2	
Fresno Teachers College	0	1
General Motors Inst.	5	
George Washington Univ.	3	
Georgia Inst. of Tech.	15	
Gettysburg College	2	
Ghent, Univ. of	1	
Girard College	1	
Harvard University	16	
Haverford College	2	
Hawaii, Univ. of	3	
Howard Univ.	3	
Idaho, Univ. of	12	2
Illinois, Univ. of	54	
Indiana Univ.	1	
Iowa State College	38	
Iowa State University	23	2
James Millikan Univ.	2	
John Tarleton Agri. College	1	
Johns Hopkins Univ.	3	
Joliet Jr. College	1	
Kansas State College	42	1
Kansas, Univ. of	18	1
Kentucky, Univ. of	10	
Lafayette College	12	2
Lawrence College	1	
Lehigh Univ.	15	
Leningrad Poly. Inst.	1	
Lewis Inst.	1	
La. Industrial Inst.	1	
La. Southwestern Inst.	2	
La. State Univ.	2	
Louisville, Univ. of	16	
Lwow, Poly. of	1	
Maine, Univ. of	21	3
Manhattan College	7	
Marine Union Jr. College	1	
Marquette Univ.	10	
Marshall College	1	
Maryland Univ. of	1	
Mass. Agri. College	1	
Mass. Inst. Tech.	45	6
McGill Univ.	9	
Mechanics Inst.	2	
Mercer College	1	
Mexico, Univ. of	2	
Michigan College Mines	5	

Institution	Members Nov. 3, 1931	Applications Received after Nov. 3, 1931
Michigan, Univ. of	47	
Michigan State College	11	
Minnesota, Univ. of	70	6
Mississippi A. & M.	4	
Missouri School Mines	10	
Missouri, Univ. of	17	1
Modesto Jr. College	1	
Montana School of Mines	11	
Montana State College	3	
Mt. Allison Univ.	2	
Nanking Tech. College	1	
Nebraska, Univ. of	24	
Nevada, Univ. of	3	
Newark College of Eng.	13	
New Hampshire, Univ. of	11	
New Mexico A. & M.	3	
New Mexico School Mines	1	
New Mexico, Univ. of	3	
New York, College of City	7	1
New York Univ.	18	2
North Carolina State College	9	2
North Carolina, Univ. of	11	
North Dakota, Agr. College	3	1
North Dakota, Univ. of	4	
Northeastern Univ.	20	1
Northwestern Univ.	7	
Notre Dame, Univ. of	1	
Norwich Univ.	3	
Nova Scotia Tech. College	1	
Ohio No. Univ.	2	
Ohio Mechanics Inst.	2	
Ohio State University	56	
Ohio University	1	
Oklahoma A. & M.	13	
Oklahoma, Univ. of	7	
Oregon State College	16	
Oregon Inst. Tech.	1	
Pasadena Jr. College	4	
Pei Yeng Univ.	2	
Penna. Military College	2	
Penna. State College	37	
Penna., Univ. of	15	1
Philippines, Univ. of	1	
Pittsburgh, Univ. of	26	
Porto Rico, Univ. of	3	
*Pratt Institute	33	4
Princeton University	12	
Purdue University	87	2
Rensselaer Poly. Inst.	13	
Rhode Island State College	5	
Rice Institute	7	
Rindge Tech. School	1	
Riverside Jr. College	1	
Robert College	5	
Rochester, Univ. of	3	
Rose Poly. Inst.	9	
Rutgers Univ.	14	
St. Thomas, College of	1	
Santa Clara, Univ. of	1	
Saskatchewan, Univ. of	2	
South Carolina, Univ. of	1	
South Dakota School Mines	11	
South Dakota State Coll.	2	
South Dakota, Univ. of	3	1
Southern Methodist Univ.	5	
Stanford University	14	
Stevens Inst. Tech.	13	1
St. John's Univ.	1	
Swarthmore College	6	
Syracuse Univ.	14	
Tangshan Univ.	1	
Tennessee Poly. Inst. of	2	
Texas Agri. College	2	
Texas A. & M.	23	
Texas College of Arts	1	
Texas College Mines	1	
Texas Tech. College	14	
Texas, Univ. of	12	
Toledo, Univ. of	4	
Toronto, Univ. of	9	
Trinity College	1	
Tufts College	18	
Tulane University	9	
Tulsa, Univ. of	1	
Union College	10	
U. S. Military Academy	3	
U. S. Naval Academy	7	
Utah Agri. College	2	
Utah, Univ. of	9	
Valparaiso Univ.	1	
Vanderbilt University	5	
Vermont, Univ. of	10	
Villanova College	1	
Virginia Military Inst.	7	
Virginia Poly, Inst.	15	
Virginia, Univ. of	13	
Washington State Coll.	9	
Washington Univ. (St. Louis)	13	3
Washington, Univ. of	16	
Wentworth Institute	5	
West Virginia Univ.	10	
Wisconsin, Univ. of	34	
Worcester Poly. Inst.	27	
Wyoming, Univ. of	7	
Yale University	38	

* Faculty 100% members of S. P. E. E.
126 new members this year.

Return to the Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Society for the Promotion of Engineering Education

Date.....

THE UNDERSIGNED desiring to become a member of

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

hereby agrees to conform to the requirements of membership, if elected and submits the following:

STATEMENT OF QUALIFICATIONS

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Print Last Name First Middle

Mailing Address (Number and Street).....

Post Office (City and State).....

Full Title of Professional Position.....
(Title) (Department)

Full Name fo Institution.....

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The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FREDERIC G. HIGBEE, EDITOR

High School Drawing—Those who have formed opinions concerning the value of high school drawing will be much interested in a statistical study by J. V. Otter, Department of Engineering Drawing, The Ohio State University. Mr. Otter has found an appreciable difference in grades among Ohio high school students in favor of students who had high school training in drawing. There is direct evidence indicating great improvement—in Ohio schools at least—in the teaching of high school drawing.

Visual Education—Those who attended the S. P. E. E. Summer School for teachers of Engineering Drawing recall J. M. Miller's "animated descriptive geometry" film. Mr. Miller is continuing his experiments in visualizing problems by this means at Rice Institute and suggests the desirability of a discussion and demonstration of the possibilities of visual aids in engineering education at the next meeting of the division.

Checking Drawings—The checking of drawings by the students themselves maintains interest and impresses students with the importance of accuracy in engineering work. In order to present student drawings for checking, three methods of projection are available: 1) the reflectoscope—unsatisfactory for a large drawing and for large classes: (2) the lantern slide—desirable but expensive; (3) the "strip" film—offering the opportunity for dozens of illustrations at negligible cost and in the time required to make a single slide.

Photographing directly on a blue positive "safety" film eliminates the necessity of making a positive print and the resulting projection takes on the characteristics of a blue print. This method offers possibilities not generally known for reproducing drawings made by students both for purposes of class illustration and checking. (Contributed by J. M. Miller, Rice Institute.)

COLLEGE NOTES

Iowa State College.—Anson Marston, dean of engineering at Iowa State College, Ames, Iowa, will retire from his administrative duties June 30. He will be succeeded by Prof. T. R. Agg, assistant dean of engineering. This change was announced recently by R. M. Hughes, president.

Dean Marston has been a member of the faculty of the College of Engineering at Iowa State for 40 years and has been dean of engineering for 28 years. He has seen the College of Engineering grow from an enrollment of about 200 in 1892 to a peak of 1900 in 1930–31. He was president of the American Society of Civil Engineers in 1929. At the present time he is a member of the Interoceanic Canal Board, appointed by President Hoover to review the proposed Nicaragua Canal and the plans for enlarging the Panama Canal.

Dean Marston will continue to devote all of his time to the college, being actively engaged in completing certain culvert and other engineering research upon which he has been engaged for several years. He will continue to teach courses in engineering valuation for senior and graduate students in engineering.

Dean Agg is an electrical engineering graduate of Iowa State College, class of 1905, but has been professor of highway engineering at Iowa State College since 1915. He has made many contributions to the literature on highway engineering, both through text books and through his research for the Iowa Engineering Experiment Station. He has been an active member of the Highway Research Board of the National Research Council.

Massachusetts Institute of Technology.—A joint meeting of the American Physical Society and the Optical Society of America opened at Technology on February 25th, with over two hundred members registering. Following conferences and a luncheon, the scientists inspected the new Spectroscopic Laboratory which was opened for the first time. The laboratory is housed in a building which is virtually a great ten-room refrigerator insulated by walls of composite construction which are four feet thick. Provision for eliminating all vibration by means of special foundations has also received attention. Electric heating maintains a temperature which will not vary more than a tenth of a degree from 68 degrees Fahrenheit. A 21 foot vacuum spectrograph, designed by Professor George R. Harrison, director of the laboratory, makes pos-

sible improved studies of light in the short ultra-violet region of the spectrum.

Following a meeting of the Corporation on March 9th, announcement was made of a plan to reorganize the administration of the Institute. The new organization provides for a Vice-President (Dr. Vannevar Bush), a Dean of Science (Dr. Samuel C. Prescott), a Dean of Architecture (Professor William Emerson), and a Dean of Engineering (also held by Dr. Bush). Explicit recognition of a Graduate School was made to meet the growing demands for post graduate study which have been made upon Technology.

SECTIONS AND BRANCHES

On account of the fact that Prof. Donaldson, who was elected president of our **Case Branch** last year, is absent on leave in Russia, and also because Prof. Albright is absent on leave for the second semester, a new set of officers has been installed for the balance of the year. A list of the new officers is as follows: President, R. C. Putnam; Vice President, E. M. Justin; Secretary, G. L. Tuve; Program Committee, R. C. Putnam, E. M. Justin, G. L. Tuve, E. J. Falkenstein, L. W. Mills. These officers assumed their duties in January.

G. L. TUVE,
Secretary.

The winter meeting of the **Minnesota Section** of the Society for the Promotion of Engineering Education was held Thursday, February 25, President George C. Priester, Professor of Materials of Engineering, presiding.

Dinner was served at 6:15 P.M. at the Campus Club.

Aside from approval of the minutes of the fall meeting, the main subject of the evening was "The New Chicago Plan of Education," presented by Dr. Richard Scammon, Dean of Medical Sciences, University of Minnesota.

Dean Scammon presented the subject in his usual inimitable manner, dealing with the historical conception of the problem, the set-up for its solution, and the recent developments affecting the divisions and the courses within these administrative divisions.

The educational phases of the problem elicited much discussion of a very practical nature.

C. F. SHOOP,
Secretary.

Tentative Program for the Meeting of the Ohio Section S.P.E.E.
Place: The Ohio State University, Columbus, Ohio. Time: Friday and Saturday, May 6 and 7, 1932.

Mathematics for Engineers. 2:30–4:00, Friday, May 6: P. W. Ott, The Ohio State University; Prof. Weaver, The Ohio State University.

The English Question. 4:00–5:30, Friday, May 6: S. A. Harbarger, The Ohio State University; C. W. Park, The University of Cincinnati; K. O. Thompson, Case School of Applied Science; Ruth Raw, The University of Akron.

Cooperative Education in Good Times and Bad. 8:30–10:30, Saturday, May 7: Fred E. Ayer, The University of Akron; E. W. Whited, The University of Pittsburgh; G. W. Burns, The University of Cincinnati; J. C. Nichols, Fenn College; B. M. Brigman, Speed Scientific School.

Economic Attitudes in Industry. 10:30–12:00, Saturday, May 7: J. A. Needy, Ohio Northern University; M. B. Robinson, Cincinnati Milling Machine Co.

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